Report No. 1130a-KO

Appraisal of the Miho Watershed Area Development Project Korea

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East Asia & Pacific Projects
Irrigation Division

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CURRENCY EQUIVALENTS

US$1.00	=	Won 485
Won 1,000	=	US$2.06
US$1 million	=	Won 0.485 billion
Won 1 million	=	US$2,062

WEIGHTS AND MEASURES (METRIC SYSTEM)

1 meter (m)	=	3.28 feet (ft)
1 kilometer (km)	=	0.62 miles
1 hectare (ha)	=	2.47 acres
1 million cubic meters (Mm^3)	=	810 acre-feet
1 cubic meter per second (m^3/s)	=	35.3 ft^3/s (cusec)
1 ton	=	1,000 kilogram (kg)
	=	2,205 pounds
1 kilogram (kg)	=	2.2 pounds

ABBREVIATIONS

ADC	-	Agricultural Development Corporation
FLIA	-	Farm Land Improvement Association
MAF	-	Ministry of Agriculture and Fisheries
NACF	-	National Agricultural Cooperatives Federation
ORD	-	Office of Rural Development
OSROK	-	Office of Supply of the Republic of Korea
OWD	-	Office of Watershed Development

FISCAL YEAR

January 1- December 31

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APPRAISAL OF THE MIHO WATERSHED AREA DEVELOPMENT PROJECT

SUMMARY AND CONCLUSIONS

i. The Government of the Republic of Korea has requested Bank assistance in financing the Miho Watershed Area Development Project. The project would provide irrigation and land development for some 12,700 ha and would directly benefit some 10,400 farm families or approximately 63,000 people. Dams and canals would be constructed to serve 8,300 ha where crop production is presently dependent on rainfall. Land development within the area to be irrigated would include conversion of uplands to paddy cultivation, land consolidation, and development of uplands for irrigated orchards and crops. Elsewhere in the project area, land consolidation would be carried out on about 3,200 ha, and 1,200 ha of uncultivated upland would be reclaimed for crop production. The project would also include construction of 150 km of gravel roads to improve access to the project area, and improvement of 80 km of river channels to reduce damage to cultivated lands during floods. Other components of the project are: surveys and mapping needed for design of project features; technical assistance; procurement of vehicles and equipment; and preparation of a feasibility study for a second-stage project in the Miho watershed.

ii. Major objectives of the Government in the agricultural sector are to achieve self-sufficiency in rice and barley, and to raise the incomes and living standards of the farming population. The proposed project is aimed at helping the Government to achieve these goals. Other Bank Group investments in the agricultural sector include: the Pyongtaek-Kumgang (Loan 600-KO) and Yong San Gang (Loan 795/Credit 283-KO) Irrigation Projects, which cover 30,000 ha and 33,000 ha, respectively, on the West Coast; a Seed Project (Loan 942-KO) to expand seed production for most of the major food crops; a Dairy Development Project (Credit 234-KO); an Agricultural Credit Project (Credit 335-KO) and an Agricultural Processing Project (Loan 994-KO).

iii. Total cost of the project is estimated at US$75 million (Won 46 billion, including provision for price increases of US$26.6 million, or 35% of the total cost. The proposed Bank loan would finance the foreign exchange component of US$29 million, or 39% of the project cost. Contracts for construction of all civil works (US$33 million excluding expected price increases) and supply of construction materials (US$4.5 million) would be awarded on the basis of international competitive bidding in accordance with Bank guidelines for procurement. Mapping services and vehicles (US$1.1 million) would be procured through normal government procedures.

iv. The Agricultural Development Corporation (ADC), a semi-autonomous agency operating under the Ministry of Agriculture and Fisheries (MAF), would be responsible for project implementation. Within ADC, responsibility for execution of the project would rest with the Office of Watershed Development which carried out the project feasibility study.

v. The project would increase production of rice by 19,500 tons, and barley by 12,500 tons. Farm income on a 0.5 ha farms benefitting from the project would increase from US$730 to US$1,100 at full development in 1986. For 1.5 ha and 2.5 ha farms the respective increases in incomes would be US$1,550 to US$2,950 and US$2,410 to US$4,560. About one-half of the farmers in the project area own 1 ha or less, one-third between 1 and 2 ha, and about two-tenths more than 2 ha. The economic rate of return for the project is estimated to be 15%. The rate of return is only moderately sensitive to increases in costs and delays in benefits.

vi. The proposed project is suitable for a Bank loan of US$29.0 million for a period of 22 years including a five-year grace period to the Agricultural Development Corporation with the guarantee of the Republic of Korea.

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

I. INTRODUCTION

1.01 The Government of the Republic of Korea has requested Bank assistance in financing the Miho Watershed Area Development Project in the central region of Korea. This would be the first Bank loan for an area development project in Korea.

1.02 The proposed project, providing irrigation and land development on 12,700 ha, is the first stage of a plan for development of the land and water resources in the Miho watershed (drainage basin). The Agricultural Development Corporation in its preparation of the project drew on the experience gained in two UNDP-assisted pilot watershed development projects. Preparation of the project was financed in part through the Seeds Project (Loan 942-KO), and UNDP made available the services of experts formerly employed on the pilot watershed projects.

1.03 This report is based on the findings of a Bank mission which visited Korea in November 1975, comprising Messrs. W.T. Smith, R. Baskett, C. Goldfinger (Bank), and L. Shanan and G. Austin (consultants). Mr. M.G. Saddington assisted in preparing the report.

II. BACKGROUND

The Agricultural Sector

2.01 Agriculture provides 25% of the GNP and 50% of the total employment. The rural population, consisting of almost 2.4 million households, accounts for 40% of the total population.

2.02 About 23%, or 2.3 million ha, of Korea's total land area is cultivated. Lowlands used primarily for rice production occupy just over 1.3 million ha and cultivated uplands account for nearly 1.0 million ha. Annual rice production in years of favorable rainfall is on the order of 4.2 million tons. Production of winter cereals, chiefly barley, generally approaches 2.0 million tons annually on a cropped area of some 1.0 million ha; about 45% of the winter cereals are grown on the lowlands after the rice harvest and the remainder as a winter crop on the uplands. Soybeans occupy the largest area of the summer crops grown on the uplands; annual production is about 300,000 tons on about 30% of the uplands. Other important upland crops are fruits, vegetables, tobacco and ginseng.

2.03 Annual food grain production has grown little over the past decade. A steady rise in rice production has been offset by declines in barley and wheat production due to conversion of uplands to paddy. Population growth

coupled with rising per capita consumption has caused annual grain imports to grow from 700,000 tons in the early 1960's to an average of 3 million tons in the period 1971-75. In 1975, food grain imports cost US$724 million. Wheat and corn account for nearly two-thirds of the tonnage of imported food grains.

2.04 The Government places high priority on expanding food grain production to achieve self-sufficiency to the extent possible. While it is realized that overall self-sufficiency will not be possible, efforts are being made to expand production of rice, barley and soybeans to meet domestic requirements. This will have to be achieved mainly through higher yields on presently cultivated land since future expansion is limited to about 200,000 ha of marginal upland soils, and tidelands that can be economically reclaimed. Rice yields are already high (ranging between 3 and 4 tons of polished rice per ha) 1/ but are still substantially below yields achieved in a similar environment in Japan. Yield increases are therefore possible through irrigation coupled with wider use of high yielding varieties. Areas devoted to winter cereals on the ricelands can also be increased where the construction of improved irrigation and drainage works allows more timely planting and harvesting of the rice crop. On the uplands, some increase in barley production should be possible through wider use of higher yielding and early maturing varieties. Some increase in wheat production in the uplands is possible, but it would be insignificant in relation to domestic requirements. Yields of other upland crops could also be increased through use of new varieties and by lime application, which would increase the response to fertilizer.

2.05 Investments in agriculture during the Third Five-Year Plan (1972-76) are expected to exceed Won 807 billion compared with Won 260 billion in the Second Plan and Won 130 billion in the First Plan. Emphasis is being placed on increasing the productivity of existing cultivated land through irrigation, drainage and flood control, and by increasing the area under high-yielding varieties of rice and other crops.

2.06 The average farm size in Korea is about 0.9 ha, of which 0.5 ha is paddy land, while the remainder grows upland crops, such as barley, maize, soybeans, fruit, vegetables, tobacco, mulberries (for silkworm production) and other cash crops. Nearly two-thirds of farm households have less than 1 ha of cropland but only 4% of farm households are landless. Most farmers own the land they cultivate, 70% being full owners and a further 23% renting some land in addition to their own. This equitable distribution of land ownership is the result of the Farmland Reform Laws of 1945 and 1950, which imposed a ceiling of 3 ha on cultivated land per household.

Rural Incomes and Employment

2.07 Higher prices for farm produce in recent years have brought rural household incomes almost on a level with those in urban areas. Government price programs have raised prices of farm products relative to prices paid

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1/ Rice yields on the farm are quoted in ton of polished rice/ha assuming a 68% milling yield. Similarly, on-farm barley yields are in ton of polished barely/ha at a 65% milling yield.

by farmers for inputs and consumption items and this has been a major factor underlying the increase in per capita incomes in the rural areas. However, since the number of workers in an average rural household is larger than in an average urban household (as women and children work in the crop planting and harvesting operations), the income of an individual rural worker still remains much lower than that of an urban worker.

2.08 Rapid growth of employment in services and industries over the past decade has led to a decline in the farm population classified as economically active. Although this trend appears to have been temporarily reversed by a slow-down in industrial growth, employment in the agricultural sector can, in the long-term, be expected to continue to decline in absolute numbers. Reduction in the number of people dependent upon Korea's limited land resources for a livelihood will help make farm mechanization profitable and contribute to increased labor productivity in agriculture.

Project Formulation

2.09 The concept of comprehensive development of selected areas was introduced to Korea by two UNDP-assisted projects for which FAO was the executing agency; ROK7 (1962-67) dealt mainly with upland reclamation, and ROK67/ 522 (1967-73) had the broader objective of comprehensive development of selected watersheds (in this context a watershed is the drainage basin of a river). UNDP/FAO specialists and government counterpart staff evolved procedures for resource inventories and project formulation and, in addition, implemented several small watershed projects.

2.10 The Bank's interest in area development stems from the 1973 Agricultural Sector Survey, which recommended that "an area and regional development approach be adopted in planning and carrying out projects to raise agricultural productivity and raise rural incomes," and suggested watershed development projects as possibilities for external financing.

2.11 As a follow-up to these recommendations, the Office of Watershed Development (OWD) in the Agricultural Development Corporation (ADC) carried out the feasibility study 1/, which forms the basis of the present project. Most of OWD's staff are former members of the counterpart team for the UNDP/FAO project, and were assisted in the study by visits from the former UNDP Project Manager and an economist. The Bank included partial financing for the study under the Seeds Project (Loan 942-KO). Development of the Naeseong watershed area has been deferred because of budgetary considerations.

2.12 The appraisal of this project has provided an opportunity to assess the comprehensive approach to area development in the context of detailed project proposals and has confirmed the value of detailed resource inventories as a basis for area development plans. Such inventories have particular relevance to Korea where, except for the coastal plains, the land is broken

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1/ "Comprehensive Development of the Naeseong and Miho Watersheds," April 1975.

up into many different types of land use and land capability. Thus, within a watershed or any other selected area, development planning has to take into account many small blocks of land and numerous small rivers and streams.

2.13 The project proposed in the feasibility report included numerous components (dams and canals, land consolidation, upland development, channel improvements, roads, rural electrification, village water supply, livestock, and fuelwood plantations). While ADC would have been responsible for the irrigation and land development works, implementation of the remaining components would have involved other agencies such as the Korea Electric Company, Ministry of Health and Social Affairs, Office of Forestry. Thus, special arrangements for inter-agency coordination would have been needed to implement a comprehensive project containing such a wide range of components in a limited geographical area. The benefits of irrigation and land development could, however, be realized without a parallel program to provide such amenities as electricity and piped water supplies. The Government has therefore concluded that the limited benefits of a comprehensive project would not warrant the establishment of a special coordinating body. Consequently, the rural electrification, village water supply and, fuelwood plantation components have been excluded from the project but would be implemented in accordance with nation-wide programs and priorities. Such programs are being carried out as part of the Saemaeul (New Community) Movement, which is aimed at improving standards of living in the rural areas. Financial assistance for these programs is being provided by the Bank under the Rural Infrastructure Project (Loan 1216-KO, 1218-T-KO). The livestock component was excluded as its economic rate of return was below 10%.

2.14 The exclusion of the above components does not, however, change the basic concept of the project which is to implement an integrated package of irrigation and land improvement works in a specific area. Past investments in irrigation have been largely concentrated on large-scale developments involving major dams and canal systems in the coastal plains. In line with its rural development policies, the Government is now placing more emphasis on land and water development in the interior regions of Korea. Two approaches are being followed. One is a nationwide program of minor irrigation projects and upland reclamation as part of the Saemaeul Movement. The second approach, typified by the proposed project, is area specific and involves the execution of larger and more complex project components than would be appropriate for implementation under the Saemaeul Movement. The Miho watershed was selected as being broadly typical of the interior regions of Korea in terms of topography, present land use, and potential for further development. The three approaches -- large-scale projects, area development, and minor irrigation -- all have a place in the Government's strategy for increasing agricultural production and farm incomes.

III. THE PROJECT AREA

Location

3.01 The gross project area covers about 77,000 ha in the northern half of the Miho river basin and is located about 90 km southeast of Seoul. It encompasses parts of three counties in Chungcheong Bug province. Jincheon, the largest town in the project area with a population of 20,000, is the chief commercial and marketing center. It is connected to the provincial capital of Cheongju, 30 km to the south, by an all-weather road. Cheongju itself lies 15 km east of the Seoul-Busan expressway. The topography of the area with its intricate pattern of hills and valleys is typical of the central region of Korea. Over one-half of the land is too steep for cultivation. Most of the suitable uplands and all of the lowland areas in the valleys are cultivated.

Climate

3.02 Korea lies in the path of warm, moist southeasterly air currents from the sea in the summer, and a northwesterly flow of cold, dry air from the Asian land mass in the winter. The summer extends from May through September with temperatures of up to 30°C and relative humidity reaching 80% in July and August. December and January are the coldest months with temperatures often below freezing. The project area has 180-190 frost-free days. Annual precipitation averages about 1,100 mm with two-thirds occurring during the rainy season (May through September). Even in the summer, rainfall is unreliable, especially during the critical rice transplanting period (June). In addition, droughts occur sometimes in August and September. Irrigation is therefore required to obtain optimum yields from high-yielding varieties of rice. Annex 1 presents climatological data.

Water Supply and Demand

3.03 Streamflow records in the project area are limited to short periods on some of the larger rivers. Consequently, estimates of runoff have been based on data from other areas in Korea with similar topography and rainfall. A high proportion (nearly 50%) of rainfall on upland catchments appears as runoff because of the steep slopes in the catchments and because most of the rainfall occurs in short, intense storms. Average annual runoff in the drainage basin of the proposed reservoirs is estimated at about 6,000 m^3/ha. The annual irrigation requirement for paddy would be about 7,000 m^3/ha in an average year and around 8,200 m^3/ha in a drought year. Reservoir storage capacities range from 30 to 50% of the mean annual runoff and would provide sufficient regulation to meet irrigation requirements except in abnormally dry years. Sediment runoff is quite low (in the range of 400-800 ton/km^2 year) and it would take many years for any significant depletion of the active storage of the reservoirs. There are no water quality data available

for rivers in the project but, since irrigation has been carried on for many years without any adverse effects, it can be safely assumed that water quality is suitable for sustained irrigation. Further details on water supply, demand and quality are presented in Annex 3.

Land Use and Soils

3.04 Present land use in the project area is as follows:

	Area (ha)	(%)
Forest	42,500	55
Cultivated Lowland	15,200	20
Cultivated Upland	13,600	18
Eroded Land	1,100	1
Other /a	4,600	6
	77,000	100

/a Includes towns, villages, roads, lakes and rivers.

3.05 About 80% of the forest land is considered as well-stocked (a generally complete cover of mature trees), and 20% consists of brush, small trees and native grass. Eroded lands are usually found at higher elevations on steep slopes with shallow soils. The potential for opening up new land for cultivation is limited to about 1,900 ha. The cultivated lowlands consist almost entirely of rice paddies. The cultivated uplands are in the form of terraces on sloping lands extending upwards from the edge of the paddies.

3.06 Upland soils are derived from the granite rocks occurring throughout the project area and are highly acid, with low cation exchange capacity, low organic content and low natural fertility. The alluvial soils of the lowlands have similar characteristics to the upland but have a higher percentage of fine-grained sediments, which inhibit internal drainage. The slow drainage of the lowland soils tends to delay planting of winter cereals following the summer rice crop.

Population, Farm Size and Land Tenure

3.07 The project area population is 165,000 people of whom 25,000 are classified as urban and 140,000 as rural. Some 10,400 farm families (63,000 persons) would benefit directly from irrigation and land development works to be constructed under the project. A further 60,000 people would benefit from the village access roads and channel improvement components. Nearly all farmers hold full title to the land they cultivate. The average farm unit is 1.2 ha, with approximately 50% of farms 1 ha or less. The farm size distribution in areas benefitting from the project is as follows:

Farm Size (ha)	Farm Holdings (No)	(%)	Cultivated Area (ha)	(%)
Less than 0.5	2,390	23	515	4
0.5 - 1.0	2,700	26	2,150	17
1.0 - 1.5	2,390	23	3,040	24
1.5 - 2.0	1,250	12	2,150	17
More than 2.0	1,670	16	4,810	38
Total	10,400	100	12,665	100

Agriculture

3.08 Rice occupies virtually all of the 15,200 ha of lowland in the summer and barley is planted on about 10% of the area in the winter. On the 13,600 ha of uplands, a variety of vegetables, soybeans and tobacco are grown in the summer, followed by barley on about 40% of the area in the winter.

3.09 About 5,700 ha of lowlands are presently irrigated from existing dams and weirs. Rice cultivation on the remaining lowlands is largely dependent on rainfall--both direct rainfall on the paddy fields and the diversion of runoff from the surrounding hillsides. Skillful water management by the farmers tends to compensate for an erratic rainfall pattern and explains the fairly high yields obtained under "rainfed" conditions. Nevertheless, lack of water in the right amount and at the right time is the most serious physical constraint on rice production outside of the areas presently irrigated. Crop cultivation on the upland areas is entirely dependent on rainfall. Upland crops are less sensitive to drought than rice, but yields and production can be significantly reduced by prolonged droughts, which cause wide swings in annual production and prices.

3.10 In 1972, a new short, stiff strawed and nitrogen responsive rice variety was released to farmers. Known in Korea as "Tongil," it has been well accepted by farmers and accounts for about 20% of the rice grown in the project area, but most of it is concentrated on irrigated lands or on lower terraces with a good water supply. Four new varieties of improved rice were released in 1975; one of them, an earlier maturing Tongil, should do well in the project area, whereas the others are probably better suited to the southern part of the country. Yields of 5 ton/ha (polished rice) for Tongil have already been reached on irrigated land in the project area. Average yields of traditional varieties, which are less demanding in terms of water supply and drainage but have lower yield potentials, are about 2.7 ton/ha under rainfed conditions and 3.1 ton/ha with irrigation.

3.11 Barley is grown as a winter crop on both the ricelands and the uplands. The crop does not tolerate excessive soil moisture and on the lowlands it is only grown on well-drained fields. On uplands, drainage is less of a problem, but the planted area is limited because planting and harvesting conflicts with the more profitable summer crops. For the project area as a whole, about 25% of the cultivated land is planted to barley. Present yields range from 1.8 to 2.4 ton/ha with an average of about 2 ton/ha. New varieties with high yield potentials were recently introduced and, with good drainage, yields of 3 ton/ha are possible.

3.12 Soybeans follow rice and barley in terms of cropped area. Yields are low, ranging from 0.8 to 1.1 ton/ha but could be increased through higher lime applications to correct soil acidity. The more popular vegetables grown on the uplands include peppers, chinese cabbage, and potatoes. Yields are high enough to produce good returns for the farmers, but much higher yields could be obtained with irrigation and improved varieties. There are many small (0.1-0.3 ha) apple and pear orchards in the project area. Under rainfed conditions yields are high enough for orchards to be profitable, but drought damage is not uncommon and irrigation would make consistently higher yields possible.

3.13 Most farmers own approximately equal areas of lowland and upland. Farming is highly labor intensive and most land preparation is by draft bullocks. In recent years, however, there has been a steady increase in the number of powered implements such as tillers, sprayers and threshers. Fertilizers and pesticides are used on nearly all crops with fairly high application rates on rice, barley and the higher value upland crops. Herbicides are used little at present, although they are becoming more widely accepted to alleviate labor shortages.

3.14 Despite the relatively high yields and intensive land use in the project area there is a considerable potential for further increases in agricultural production through irrigation and land development. Rice farmers throughout Korea have shown their ability to take full advantage of irrigation and drainage facilities. The provision of a timely and reliable water supply would increase rice yields and also have the effect of reducing peak labor demands since crop calendars would no longer be governed by rainfall. Better timing of the rice crop would also lead to an increase in the area planted to barley. In irrigated areas, land consolidation would have a number of advantages: higher yields through better water control; lower labor requirements as a result of easier access and conditions more suited to mechanical land preparation; and an increased area under barley due to better drainage. Conversion of uplands to paddy cultivation is also possible in areas which can be supplied with irrigation water. Finally, there is the possibility of converting forest lands to crop production and orchards.

Existing Infrastructure

3.15 About 3,900 ha of ricelands are irrigated by numerous small dams and weirs. Many of the small dams, irrigating only 10 to 20 ha, are located at the head of the paddy terraces on side valleys of the main rivers. There

are two large dams in the project area -- Baekgok and Jopyong. Baekgok irrigates about 1,800 ha, but water from Jopyeong is only used outside of the project area. Except for 130 km of gravel roads, maintained by the counties, the roads and tracks leading to most of the villages are too narrow for motor vehicles. Nearly 60% of the households have electricity and more are to be electrified in the next two or three years as part of a government program to bring electricity to 85% of the rural households in Korea. Most of the villages rely on communal wells for their water supply. At present only 5% of the villages have piped systems but more systems are planned under a nation-wide village water supply program (para 2.14).

IV. THE PROJECT

Project Components

4.01 The proposed project would increase agricultural production and farm incomes on about 12,665 ha. 1/ The project works would irrigate 8,315 ha of land where crop production is presently dependent on rainfall. Within the irrigated area various forms of land development would be carried out including the conversion of uplands for paddy cultivation, land consolidation, and development of uplands for irrigated orchards and cash crops. Land development on 4,350 ha outside of the areas to be irrigated by project works includes land consolidation on presently irrigated land, and development of uncultivated uplands for rainfed crops (upland reclamation). The project components are summarized below:

(a) construction of dams and canals to irrigate 8,315 ha;

(b) conversion of 2,045 ha of cultivated upland to irrigated paddy fields in areas commanded by the above canals;

(c) land consolidation, including construction of ditches, drains and farm roads together with land levelling and boundary realignment on 4,600 ha (3,150 ha on presently irrigated land and 1,450 ha in areas to be irrigated by the project);

(d) development of 495 ha for irrigation of upland crops, and 550 ha for orchards within the area to be irrigated;

1/ In the text and annexes, areas are rounded to only 5 ha, instead of the normal practice of rounding to 100 ha or more, because of the small scale of individual components and in order to maintain numerical consistency.

(e) upland reclamation, primarily bench-terracing, of 1,200 ha of presently uncultivated land;

(f) improvement of about 80 km of river channels to increase their flood discharge capacity;

(g) construction of about 150 km of village access roads;

(h) aerial photography, surveys, and mapping for the design of project works; and

(i) provision of technical assistance, procurement of vehicles, and a feasibility study for a second-stage project in the Miho Watershed.

The components of the project are described below; further details are given in Annex 2 and cost data are given in Annex 4.

Dams and Canals

4.02 The project would provide irrigation facilities for an area of 8,315 ha, of which 7,115 ha would be served by four independent irrigation units, each with its own dam and canal system, and the remaining 1,200 ha by 22 small dams and weirs. Principal features of the four irrigation units are briefly summarized below and further details are given in Annex 2.

Unit	Service Area (ha)	Dams
Kumwang	1,500	Two dams with heights of 20 and 26 m with a combined storage of 8.8 Mm^3 serving a common canal system.
Maengdong	2,360	A 29 m high dam forming a 9.8 Mm^3 reservoir, linked by a 900 m tunnel to a 1.2 Mm^3 diversion reservoir in an adjacent drainage basin.
Baekgok	1,685 1/	An existing 17 m high dam to be raised by 5 m to increase storage from 7.0 to 17.0 Mm^3.
Weonnam	1,570	A 25 m high dam storing 7.7 Mm^3 with an 1,800 m tunnel leading to the canal headworks.

1/ 1,685 ha is additional to 1,750 ha already being irrigated, with the project a total of 3,435 ha would be irrigated.

4.03 All dams would have earth and rockfill embankments with an adjacent concrete spillway. Designs vary according to foundation conditions and the types of fill available within a reasonable haul distance, but generally the dams have a central clay core surrounded by random fill. Ample deposits of random fill, often with a high gravel content, are generally found near the damsites. Suitable core material is less abundant, but can usually be located within a reasonable haul distance.

4.04 For the areas served by the four irrigation units, about 130 km of main canals and 140 km of laterals would be constructed. These would be unlined canals except for short sections in permeable soils, which would be lined with concrete. Numerous tunnels, culverts and other structures would be needed because of irregular topography along the canal alignments. The areas to be irrigated are generally narrow strips of land along the river valleys, seldom more than 500 m wide and, consequently, the main canals and laterals would serve much smaller blocks of land than is normally the case in large irrigation systems. Therefore, following the usual practice in Korea, the on-farm distribution systems would be built by farmers, except for some large blocks totalling 1,450 ha where land consolidation would be carried out (para 4.06).

Land Development

4.05 Conversion of Uplands to Paddy. In areas to be irrigated by the project works, 2,045 ha of cultivated uplands would be converted to paddy cultivation. The areas to be developed have slopes up to 15% and they would be converted into a series of horizontal benches with widths ranging from 5 to 10 m depending on the slopes. Uplands to be converted have been carefully selected to ensure that soils are suited to paddy cultivation and to avoid disturbing high-value crops such as orchards and ginseng plantations.

4.06 Land Consolidation. This work would be carried out on 1,450 ha, or 20%, of the paddy land in the areas to be irrigated by the project works and on 3,150 ha, or 55%, of the paddy land which is already irrigated in the project area. Land consolidation consists of replacing the existing uneven pattern of small irregular plots with larger level plots in a rectangular grid of ditches, farm roads and drains. Boundary rearrangement leads to minor changes in size of individual holdings, but there is no change of ownership. Land consolidation, which has been carried out in large areas of irrigated land in Korea, improves water management and facilitates mechanical land preparation, which in turn result in higher rice yields and an increase in the area of winter barley.

4.07 Land consolidation can generally be justified only in fairly large blocks where land slopes are less than 2%, since on steeper slopes earth-moving costs become prohibitive. Irrigation in the Miho watershed was first established on flat and level blocks of land which could be easily commanded by weirs on the main rivers. Hence, a larger part of the presently irrigated land is more suitable for land consolidation than the steeper areas to be

served by the project facilities. Up to the late 1960's most of the land consolidation in Korea was carried out on large blocks of flat land (less than 0.5% slope), and topography was not a significant factor in the designs. As land consolidation came to be applied to steeper land, up to 2% slope, design procedures were modified to take more account of topography in order to minimize earthwork quantities. The Bank has participated in the evolution of design principles for land consolidation through its supervision of ongoing Bank-financed projects.

4.08 Furrow Irrigation. An area of 495 ha of uplands, of which 410 ha is presently cultivated and 85 ha is uncultivated, would be developed for furrow irrigation. In these areas the soils are too shallow to be benched for paddy cultivation. About 60% of the area has slopes in the 5-10% range, and 40% has slopes up to 15%. Development would consist of land clearing, grading, rearrangement of property boundaries, and construction of tertiary lands, drains and farm roads.

4.09 Orchards. There are about 550 ha of uncultivated land with fairly steep slopes (15-35%) in small plots close to the proposed canal alignments. The access provided by the canal roads and the availability of water would provide a strong incentive for development of these lands as orchards. The land would be cleared and graded as part of the project, but orchard establishment would be left to the farmers.

4.10 Upland Reclamation. Most of the cultivable land in the watershed is already being farmed, but detailed surveys have revealed numerous small areas of uncultivated land totalling about 1,800 ha, which could be developed for crop production. About 1,200 ha of uncultivated land with slopes in the 10 to 20% range would be developed for the production of rainfed upland crops, including barley, soybeans, fruits and vegetables. There are basically three alternative methods of development for upland areas -- bench terracing, semi-bench terracing (the area between benches is sloped at about 5%), and contour farming with buffer strips and drains. The selection of the method of development depends not only on land slopes and soil characteristics, but also on the crops to be grown, taking into account such factors as farm size and market demand. Surveys indicate that bench-terracing would be appropriate in the project area since the soils are generally deep and of medium fertility. This would be confirmed as planning and design proceeds. As the existing ADC standards for the design and construction of upland reclamation are not suitable (see Korea: Rural Infrastructure Appraisal Report, February 15, 1976 for details), assurances were obtained that ADC shall use and maintain such design standards for upland reclamation as shall be agreed with the Bank. The standards to be employed would be similar to those agreed upon for the Rural Infrastructure Project.

Channel Improvement

4.11 Sections of river channels with a total length of about 80 km would be improved to prevent flooding of cultivated land bordering the rivers. Floods occur several times during the rainy season and can damage rice and

other crops. Channels would be deepened and in some cases straightened. Materials excavated from the rivers would be used to construct about 100 km of flood embankments, or levees, about 2 to 3 m high, to protect low-lying areas. A continuous line of levees along both sides of the channels is not needed. The top of the levees would carry a 3.5 m wide gravel road. Drainage outlets with flap gates would be placed at intervals of about 400 m along the levees to permit drainage of land behind the levees.

Village Access Roads

4.12 About 150 km of four to five m wide gravel surfaced roads would be constructed in the project area to provide access for equipment and vehicles to areas where irrigation and land development would be carried out. These roads would also serve as part of the county road system linking the village to existing national or provincial highways. The project areas are traversed by a large number of tracks, but few of them are wide enough for motor vehicles and often become impassable during the rainy season. Some village roads have been constructed under the Saemaeul Movement (para 2.15), but these are mostly short links from a main road to a nearby village. Roads to be constructed under the project would be unsuitable for inclusion in the Saemaeul Program because they are too long (5 to 10 km) for construction by manual labor and because they must be built in coordination with other project construction activities.

Feasibility Study for Stage II

4.13 The feasibility study for the second-stage project in the remaining 110,000 ha of the Miho watershed would be carried out by ADC. Primary responsibility within ADC would be assigned to the Office of Watershed Development (para 5.02), whose capacity to carry out such a study was demonstrated in the preparation of the proposed project. A project formulation report based on field surveys, and existing maps and aerial photography, would be prepared by December 1977 and submitted to the Bank for review and comment. This report would identify the principal features of the project; describe requirements for mapping, site investigation, farm surveys; and present a work program for completion of the feasibility report by June 1979. Korean consultants, and foreign specialists on short term assignments, would be employed by ADC, to supplement their own staff resources in carrying out the study. Assurances were obtained that ADC would employ these consultants on terms and conditions acceptable to the Bank. In addition to preparation of irrigation and land development components, the study would also include a survey to determine the possibilities of increasing productivity of presently cultivated uplands, with particular reference to agricultural extension and credit.

Surveys and Mapping

4.14 Aerial photography of the project area to a scale of 1:15,000 was carried out in 1972. This was used for the resource inventory forming a basis for the feasibility report. Photography to a scale of 1:8,000 is required to prepare maps for land acquisition and for detailed designs. Damsites would be mapped to a scale of 1:1,200 and areas scheduled for land

development, reservoirs, and canal alignments would be mapped at a scale of 1:3,000. The maps would be prepared by photogrammetry, but ground surveys would be carried out in areas where land development is planned to attain the necessary precision in ground surface elevations. Contractors would be employed for aerial photography, photogrammetry and ground control surveys. ADC surveyors would undertake supplementary ground surveys.

Status of Designs

4.15 Preliminary designs have recently been completed for all of the dams serving the four independent irrigation units. These are based on accurate topography and adequate foundation and material investigations. Detailed designs are unlikely to change quantities of the major work items. Preliminary designs have been prepared for all main canals and laterals. In some cases, however, the canals were aligned to command larger areas of upland than it is now proposed to irrigate. Changes in alignments to take account of this could possibly lead to cost savings in the canal systems. After finishing the final design and before proceeding with construction of the small dams, ADC has agreed to provide the Bank with basic data, and estimates of costs and benefits for the Bank's review and comment. Designs have been made of sample areas for land consolidation works and 10% of the length of roads and channel improvement to form a basis for cost estimates.

Implementation Schedule

4.16 The project would be implemented over a period of five and a half years, from July 1976 to December 1981 (Chart No. 15823). The first year would be taken up by purchase of right-of-way, preparation of designs and contract documents, and award of contracts. Construction of the project works would begin in October 1977 and all works would be completed by mid-1981. In Korea, contractors are able to work year-round on dams and canals. Development works on cultivated land (conversion to paddy, land consolidation and furrow irrigation) have to be scheduled during the winter to allow the farmers to plant the main season (May-October) crop. However, such works can be carried out in advance of the main irrigation facilities, since rainfed crop production on developed land could continue until irrigation water becomes available.

Cost Estimates

4.17 The total project cost is estimated at US$75.0 million, of which US$29.0 million or 39% is foreign exchange. The cost estimates are based on quantity and unit price estimates prepared by ADC, with unit costs having been updated to actual January, 1976 levels. Unit prices were calculated using a standard government procedure which, for each work item, estimates equipment use (depreciation and operation), labor, materials and contractor's profit. The unit prices are in line with recent bid prices for similar work. Physical contingencies of 15% have been applied to the base cost estimates for civil works. Engineering and administration has been taken as 10% of the construction cost (including physical contingencies). Costs due to expected price increases over the implementation period amount to about 35% of total project costs and assume the following annual inflation rates:

	Price escalation rate (%)					
	1976	1977	1978	1979	1980	1981
Civil Works	15	12	12	12	10	10
Equipment & Services	10	8	8	8	7	7

The 1976 price escalation rates are those suggested by ADC. The rates for 1977-81 follow the Bank guidelines. Details of the project costs are presented in Annex 4 and summarized below:

	Local	Foreign	Total	Local	Foreign	Total	Foreign Exchange	% Base Cost
	(Won B)			(US$ M)			(%)	(%)
Dams and Canals	5.2	4.3	9.5	10.8	8.8	19.6	45	45
Land Development	2.8	2.3	5.1	5.9	4.6	10.5	45	24
Channel Improvement	0.4	0.3	0.7	0.8	0.6	1.4	45	3
Village Access Roads	0.4	0.3	0.7	0.8	0.7	1.5	45	4
Mapping, consultants & vehicles	0.1	0.4	0.5	0.2	0.8	1.0	80	2
Feasibility studies	0.3	0.2	0.5	0.5	0.5	1.0	50	2
Right-of-way	2.3	0	2.3	4.8	0	4.8	0	11
Engineering & Admin.	1.6	0.3	1.9	3.3	0.6	3.9	15	9
Base Cost Estimate	13.1	8.1	21.2	27.1	16.6	43.7	38	100
Physical Contingencies	1.4	0.9	2.3	2.9	1.8	4.7	38	11
Expected Price Increases	7.8	5.1	12.9	16.0	10.6	26.6	40	61
Total Project Cost	22.3	14.1	36.4	46.0	29.0	75.0	39	171

Financing

4.18 The proposed Bank Loan of US$29.0 million would finance the full foreign exchange requirement of the project. Local expenditures, representing the estimated balance of project costs, would be met through annual Government budgetary allocations to ADC. While most construction funds would be channelled through ADC, for upland reclamation works the Government would lend NACF 30% of the capital cost at 8% interest, with repayment over eight years, including a three-year grace period. NACF would on-lend these funds to the farmers at 9% interest and the same repayment terms. Assurances were obtained that the Government and NACF would make these loans.

Procurement

4.19 Contracts for civil works construction, and for the supply of cement and reinforcing steel would be awarded on the basis of international competitive bidding in accordance with Bank Group Guidelines. The domestic

civil engineering contracting industry has grown rapidly in recent years and has demonstrated considerable capacity and competence to perform major public works in Korea as well as overseas. Most local contractors are well equipped and are expected to be the successful bidders on all contracts under the project. ADC's policy is to supply contractors with the cement and steel to be incorporated in the works. These materials would be procured in bulk on behalf of ADC by the Office of Supply, Republic of Korea (OSROK). A preference limited to 15% of the cif price of imported goods or the customs duty, whichever is lower, would be extended to local manufacturers in the evaluation of bids.

4.20 The total value of all civil works contracts (exclusive of price contingencies) would be about US$33 million. Civil works would be packaged together by areas to form about five contracts with an average value of about US$6 million. Contracts for cement (US$2.0 million) and reinforcing steel (US$2.5 million) would be divided into contracts of about US$ 0.5 million in order to keep the supply of materials in line with requirements. Aerial photography and mapping services (US$0.5 million) and vehicles (US$80,000) would be procured through normal government procurement procedures. There are sufficient suppliers of such services and goods to ensure adequate competition.

Disbursements

4.21 Disbursements would be made at the rate of 100% against the foreign exchange cost of directly imported equipment and materials, and 65% of expenditures for equipment and materials manufactured locally. For consultants' services, disbursements would equal 65% of local costs or 100% of foreign expenditures. Disbursements for civil works carried out by contractors would be at 40% of total expenditures, to be disbursed against certified monthly contractors' progress payment. Undisbursed funds would be cancelled unless an alternative use was approved by the Bank. The estimated schedule of expenditures on the project and the disbursement schedule are presented in Annex 5. It is expected that disbursements would be completed by June 1982.

Accounts and Audits

4.22 Assurances were obtained that ADC would maintain separate accounts for the project and would employ independent auditors, acceptable to the Bank to audit project accounts annually; and that the audited accounts, together with the auditor's comments, would be sent to the Bank within four months of the close of each financial year.

Environmental Effects

4.23 Experience in Korea has demonstrated that the development of irrigation would have no adverse effects on the environment. On the benefit side, drainage would be improved under the project and the reservoirs would reduce the frequency of floods and damage to cultivable land.

V. ORGANIZATION AND MANAGEMENT

Agricultural Development Corporation

5.01 The Agricultural Development Corporation (ADC), a semi-autonomous agency operating under the Ministry of Agriculture and Fisheries (MAF), would be responsible for project implementation. ADC was created by the Rural Modernization Promotion Law (Law No. 2199) of January 12, 1970, which merged the Union of Land Improvement Associations (ULIA) and the Ground Water Development Corporation. The predecessor institution of the ULIA was formed in July 1940. The main activities of ADC are the promotion of agriculture through development of land and water resources, and the provision of technical assistance to Farm Land Improvement Associations (FLIA) (para 5.12). ADC is headed by a president, who is assisted by a vice president, and a six-man board of directors. The president, who nominates all his staff including department heads, is appointed by the President of the Republic of Korea, while the vice president, auditor and directors are appointed by the Minister of Agriculture and Fisheries (Chart No. 15825).

Project Implementation

5.02 Responsibility for designs, procurement and construction supervision would rest with ADC's Office of Watershed Development (OWD), which carried out the project feasibility study. This is in line with ADC's normal practice whereby special units, under a project manager, are set up with the necessary technical and administrative staff to implement specific projects. The Manager of OWD would serve as project manager under the general supervision of one of ADC's directors. Some of OWD's key personnel gained experience in the design and execution of irrigation and land development works through their participation in the UNDP upland development and watershed projects (para 2.11). Additional staff would however be needed, and assurances were obtained that ADC would assign to OWD, as and when needed, the technical and administrative staff required to implement the project, and appoint a project manager whose qualifications and experience shall be acceptable to the Bank.

5.03 ADC would employ consultants on periodic short-term assignments to assist OWD in the final designs of the dams and canals. The consultants, an expert in canal design and an expert in the design of dams, would review the designs before they are finalized to identify and recommend possible savings in costs and improvements in operating efficiency and safety. Each consultant would be employed for a total of twelve months. In employing these consultants ADC would be supplementing its own senior technical staff who face a considerable work load from ongoing and planned projects and ADC's own technical assistance activities. Assurances were obtained that ADC would employ the above consultants on terms and conditions acceptable to the Bank.

5.04 Land acquisition for right-of-way and property compensation on ADC projects is handled by the provincial authorities with funds provided

by ADC. Assurances were obtained that land and rights to land and property would be acquired in a timely manner to avoid any delays in project construction.

Agricultural Supporting Services

5.05 Agricultural services in the project area, described below and in Annex 7, are well organized and would provide adequate support to farmers in realizing project benefits. The project area is practically all (96%) within the province of Chungcheong Bug, with the provincial administration at Cheongju. The remainder of the project area lies in Gyeonggi province.

5.06 Agricultural Research and Extension. The Office of Rural Development (ORD) within MAF is the agency with primary responsibility for agricultural research, extension and training. Its principal research activities are conducted at its headquarters at Suwon, 25 km south of Seoul. The provincial ORD at Cheongju is responsible for research and extension in the project area. Research is currently aimed at crop yield improvement, earlier maturing varieties, and disease or insect resistance. Trials or plots at the county level may be part of a research effort, but are usually designed to demonstrate new or proven practices to the farmers. The experimental and demonstration results of research are well documented. Extension pamphlets and posters are adequate for current extension needs. The four counties included in the project area have 145 extension workers to serve about 75,000 ha of farms, averaging about one worker to 500 ha or 400 farmers. The existing extension system works satisfactorily as is evidenced by the relatively high yield level even under existing rainfed conditions.

5.07 Cooperatives. Almost all supplies of inputs and credit originating from Government sources are supplied through the cooperative system. It also handles marketing of a number of crops. Some 90% of project area farmers are members of district cooperatives. These primary cooperatives are successively grouped into county agricultural cooperative federations and ultimately the National Agricultural Cooperatives Federation (NACF).

5.08 Although NACF is the apex of the rural cooperatives, it actually functions as a Government trading and banking agency. The president of NACF is appointed by the President of Korea, and the managers of the provincial NACF and county cooperatives are in turn appointed by the NACF president. While the Government effectively channels inputs and credit and assists farmers in marketing farm products through the cooperatives, they also serve the farmers in making their needs known to Government. Other farmer organizations in the project area are the Farm Land Improvement Associations (FLIA), which operate and maintain irrigation and drainage facilities. They are described in para. 5.12.

5.09 Fertilizer and Seed. Annual fertilizer consumption in the project area is currently some 2,950 nutrient tons, consisting of 1,370 tons nitrogen; 840 tons phosphoric acid; and 740 tons potash. Lime is applied to a small area (370 ha) of upland crops. At full development the project would require some 5,500 nutrient tons of fertilizer annually, consisting of 2,520 tons of nitrogen; 1,580 tons of phosphoric acid; and 1,400 tons of potash. As well,

1,560 tons of lime would be required for upland crops. NACF currently supplies all fertilizers through the district cooperative depots in the project area, and would be able to handle easily the increased demand.

5.10 The Chungcheong Bug provincial ORD multiplies foundation rice, barley, wheat, soybean and potato seed to produce registered seed at the ORD seed farm in Cheongju. Selected seed growers in the villages then use the registered seed to produce certified seed, which they sell to farmers. At full development the project would use approximately 100 tons of certified rice and 100 tons of certified barley seed annually. A new national system for quality seed supply is presently being established with financial assistance from the Bank (Loan 942-KO), and no problems are expected in obtaining the quantities of seed needed.

5.11 Credit. An estimated 15% of project area farmers finance their requirements of farm inputs and hired labor from their own resources. The remainder use credit from the NACF, money lenders, millers or relatives. The NACF supplies approximately 50% of the farmers' production credit needs, providing six-month loans at 1% interest per month. NACF's annual production loans in the area amount to some Won 430 million (US$0.9 million), and are limited by budgetary constraints. Credit from other sources is usually much more expensive, with money lenders charging 3%-5% interest per month. At full development, an estimated 8,800 farmers would require an estimated Won 1,100 million (US$2.3 million) production credit annually. The NACF project area operations would have to expand by 150% to supply this sum. An additional US$2.2 million of longer term credit would be required for farm machinery purchases. Administratively, there would be no difficulties in handling the increased volume of credit, provided the funds are made available. Because of the need for credit to finance the larger volume of farm inputs and machinery requirements under the project, assurances were obtained that the Government would make the necessary arrangements to meet the farmer's short and long term credit needs.

Operation and Maintenance

5.12 Responsibility for operation and maintenance (O&M) of existing irrigation projects in Korea rests with the FLIA's. These associations operate as independent units although their annual operating budgets must be approved either by the Provincial Government or the MAF, depending on the size of the project. Most FLIA's also engage extension workers to assist their members. Three FLIA's, presently operating 5,700 ha in the project area, would be responsible for the additional areas to be developed by the project. The FLIA's would operate and maintain the irrigation systems, schedule water deliveries, allocate and collect project charges, provide extension service and enter into cooperative arrangements with other agencies, such as NACF and ORD, for various kinds of assistance to the farmers. Several small irrigation systems, which would be constructed in isolated areas, would be operated by Water User Groups or Hung Nong Gaes (HNG's). ADC would establish these groups, which may in time become big enough to form FLIA's, or join with existing FLIA's. The standard of O&M on existing irrigation systems in the project

area is generally quite satisfactory. The cost of adequate O&M (in early-1976 prices) would average about Won 27,650/ha (US$57/ha). Maintenance of the village access roads would be the responsibility of the counties.

Cost Recovery

5.13 In areas irrigated by the project, farmers would pay the full cost of O&M, through a water charge imposed and collected by the FLIA, as well as an annual charge for repayment of 30% of the capital cost of the irrigation facilities (about US$3,800/ha on average excluding the farmers' labor used to construct the on-farm network) at 3.5% interest over 35 years (Annex 9). Farmers also pay a production tax of 6% on all foodgrain production above 1.4 ton/farm on the ricelands, and 6% of the gross value of crop production above Won 85,000/ha on the uplands. Using a discount rate of 10% and a period of 35 years, this implies a cost recovery index of 36%. At full project development on a 1.5 ha farm, incremental O & M charges, capital repayments, and direct taxes due to the irrigation facilities would be about Won 100,000 annually, or 18% of incremental income (Won 562,000/year). The beneficiaries of upland reclamation would repay 30% of the capital cost (about US$1,650/ha on average) at 9% interest, with repayment over eight years, including a three-year grace period. At a 10% discount rate, the proposed terms imply a cost recovery index of 41%.

5.14 The above charges are compared in Annex 9 with the "project rent," which is defined as incremental net farm income before paying water charges less the imputed value of family labor, farm management, the return on the farmer's own capital investment, taxes and an allowance for risk/uncertainty. The implications of the proposed charges for income distribution are also examined. According to this analysis, the proposed charges are about 27% of project rent, for the smaller farmers, and about 20% of project rent for the larger farmers. A forthcoming Bank economic mission will review price policies in the agriculture sector and urban/rural income distribution which have a bearing on appropriate levels of cost recovery. At present the Government's repayment policy is uniform throughout the country, and laid down by law. Any change to this law should await discussion of the mission's findings with the Government. In suggesting this action, it is pointed out that:

(a) the absolute level of project charges and general taxes at full development is considerable, varying from US$190/ha to US$260/ha;

(b) the collection of water charges in Korea is commonly greater than 98% of assessments.

5.15 Assurances were obtained from the Government that project farmers would contribute to the capital and annual costs of the project facilities at the levels described in para 5.13.

VI. PRODUCTION, PRICES AND FARM INCOMES

Production

6.01 Implementation of the project would lead to changes in land use, a more intensive cropping pattern, and higher yields. Upon completion, the project net cultivable area would increase by 1,835 ha to 12,665 ha; and the irrigated area would increase from 3,150 ha to 11,465 ha. The remaining 1,200 ha would be rainfed. Annual cropping intensity would increase from 117% to 138%. Adequate irrigation facilities, land consolidation, flood control and expanded credit supplies would encourage increased plantings of high yielding rice varieties, good quality varieties for other crops, heavier fertilizer applications, and greater use of crop protection chemicals. To overcome labor shortages, the use of machinery would increase for land preparation, threshing and hauling. At full agricultural development in 1986, most farmers are expected to thresh their rice and barley crops mechanically, use a combination of machinery and animal-drawn implements for land preparation, and mechanically haul most farm inputs and produce.

6.02 At full development, estimated rice yields for consolidated and non-consolidated areas would average 4.5 ton/ha per crop (polished rice). Estimated barley yields would average 2.6 ton/ha per crop irrigated, and 2.4 ton/ha per crop rainfed. Farmers would achieve these yields five years after the completion of project works or introduction of water on areas to be irrigated. Annual rice production would increase to about 47,000 tons, from present 24,000 tons, and annual barley production would increase to about 12,500 tons, from the present production, 3,600 tons.

Prices

6.03 All prices have been adjusted to a January, 1976 level; whenever possible crop prices for economic analysis have been based on the Bank's projections of 1985 world market prices. Thus the world market price was used for rice, soybeans, tobacco and fertilizer. In the absence of price forecasts for polished barley for human consumption, a price equal to 85% of that projected for wheat flour was used because, based on observed price trends, this is the price ratio between the two products on the local market. For other crops, and for farm income analysis, average farmgate prices for the last five years (adjusted for inflation) have been used. As there is little market for fuelwood, the value was determined in terms of agricultural residues and coal, the alternative fuels for which it would be substituted.

Farm Incomes

6.04 For the purpose of farm income analysis, three representative farm models were examined; 0.5 ha; 1.5 ha; and 2.5 ha. Land use and cropping patterns for the present condition broadly reflect averages for cultivated lands in the project area. The future condition assumes that the 0.5 ha farms would be entirely under irrigation; the 1.5 ha and 2.5 ha farms would

have irrigation facilities for 90% of their net cultivable area. The analysis' results are summarized below and shown in further detail in Annex 8. Net farm income is equal to the gross value of production less cash inputs, hired labor costs, taxes, O & M charges and capital repayments, plus income earned off-farm or from non-farming sources.

Farm Size (ha)	Cropping Intensity		Farm Income/a			
	Present	With Project	Present	With Project	Present	With Project
	(%)		(Won '000)		(US$)	
0.5	120	140	420	590	870	1,220
1.5	113	137	800	1,475	1,650	3,040
2.5	113	137	1,205	2,240	2,480	4,620

/a Rounded to nearest Won 5,000 and US$10, and includes off-farm and non agricultural income.

6.05 Present net farm incomes vary from won 420,000 (US$870) on a 0.5 ha farm to Won 1,205,000 (US$2,480) on a 2.5 ha farm. Similarly at full development net farm income would vary from Won 590,000 (US$1,220) on 0.5 ha to Won 2,240,000 (US$4,620) on 2.5 ha. This represents a 40%-85% income increase, and indicates that the farmers would have sufficient financial incentive to participate in the project (Annexes 8, 9).

6.06 Although comparisons of farm incomes based on farm budgets with income data based on national accounts aggregates must be interpreted with caution, they do present a rough picture of the relative income position of project beneficiaries. With an estimated six persons per family and one family per farm, present per capita farm income (US$145-US$415) is about 25%-75% of the estimated 1976 per capita GNP of US$545. Providing the farming population remains constant, at full project development in 1991 the projected per capita farm income is estimated to be 25%-85% of the then per capita GNP. The project would slightly narrow the income gap (which without the project is expected to widen) between the farmers in the area and the national average per capita income.

6.07 About one-third of the projects' farm families are currently estimated to have per capita incomes below the absolute poverty level of around Won 80,000 (US$165). At full agricultural development the project would increase this group's incomes on average by 50%, taking about half the farmers in the group above the absolute poverty level.

VII. BENEFITS, JUSTIFICATION AND RISKS

7.01 The proposed project would directly benefit some 10,400 farm families or approximately 63,000 people. The project works would increase yields and production on nearly 12,700 ha through irrigation and land development,

including developing of about 1,800 ha of presently uncultivated land for crop production. By increasing annual cropping intensity and the net cultivable area, the project would create a demand for an additional 496,000 man-days of farm labor per year, or about 2,100 man-years. The proposed village access roads would facilitate the moving, and reduce transport costs, of farm inputs and produce; allow villagers to more fully enter the market economy; and enable children from more isolated areas to attend school. The project would support the Government's policies to increase foodgrain production, and reduce income disparities between rural and urban incomes.

7.02 The project's overall economic rate of return would be 15%, using a 35-year evaluation period; full project benefits being attained in 1991 ten years after completion of construction; farm gate prices for rice, soybean, tobacco and fertilizer based on the Bank's commodity price forecasts for 1985 expressed in January 1976 constant prices; a shadow foreign exchange rate of US$1.00 = Won 560; an average shadow wage rate for unskilled labor of Won 1,450 per man-day; and assuming the project facilities have a salvage value of 25% of their original cost at the end of the evaluation period. Individual project components were also evaluated, and showed economic rates of return from 12% for both the small dams and Weonnam dam and facilities to 35% for upland reclamation works (Annex 10).

7.03 The project's rate of return showed little sensitivity to variations in the cost estimate or assumptions made concerning the timing of agricultural benefits. It showed more sensitivity to a reduction in the level of benefits, emphasizing the importance of the timely availability of adequate credit and other farm inputs. In none of the cases tested, however, did the rate of return for the entire project fall below 12%. On the other hand, if project benefits turn out to be 25% higher than forecasted because of higher commodity prices, the rate of return would be 18%.

7.04 At full agricultural development the project would result in rice import savings of Won 3,500 million (US$7 million) annually at the projected world market price cif Incheon/Busan (Annex 10). After deducting the incremental cost of imported fertilizers, chemicals, fuel annd other farm inputs, annual net foreign exchange savings would amount to about Won 2,500 million (US$5 million).

7.05 In implementing the project, risks to be met are no greater than can normally be expected with operations of this type.

VIII. AGREEMENTS REACHED AND RECOMMENDATION

8.01 During negotiations, agreement was reached with the Government on the following principal points:

(a) ADC shall use and maintain such design standards for upland reclamation as shall be agreed with the Bank. The standards to be employed would be similar to those agreed upon for the Rural Infrastructure Project (para 4.10);

(b) ADC would engage consultants on terms and conditions acceptable to the Bank to assist OWD with the Feasibility Study for Stage II (para 4.13);

(c) the Government wold lend NACF 30% of the capital cost for upland reclamation at 8% interest, with repayment over eight years, including a three-year grace period. NACF would on-lend these funds to the farmers at 9% interest and the same repayment terms (para 4.18);

(d) ADC would maintain separate accounts for the project and would employ independent auditors, acceptable to the Bank, to audit project accounts annually; and that the audited accounts, together with the auditors's comments, would be sent to the Bank within four months of the close of each financial year (para. 4.22);

(e) ADC would assign to OWD the technical and administrative staff needed to implement the project, and appoint a project manager whose qualifications and experience would be acceptable to the Bank (para. 5.02);

(f) ADC would engage consultants on terms and conditions acceptable to the Bank to assist OWD in the final designs of the dams and canals (para. 5.03);

(g) ADC would make the necessary arrangements to ensure the purchase of land and rights to land and property in a timely manner to avoid any delays in project construction (para 5.04);

(h) the Government would make the necessary arrangements to meet the farmers' short and long term credit needs (para 5.11); and

(i) Project farmers would contribute to the capital and annual costs of the project facilities at least at the levels described in para 5.13 (para 5.15).

8.02 With the above agreements, the proposed project would be suitable for a Bank loan of US$29.0 million for a period of 22 years including a five-year grace period to the Agricultural Development Corporation with the guarantee of the Republic of Korea.

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Climatological Data Miho Watershed

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Rainfall 1/ (mm)													
Average	36	35	55	85	98	125	311	283	150	55	49	14	1,296
Maximum	100	72	166	187	252	265	694	545	348	121	95	32	1,676
Minimum	0	12	1	14	36	42	89	136	15	11	14	6	884
Number of rainy days 2/	9	7	5	6	8	7	12	12	9	7	10	6	98
Temperature (°C) 2/													
Mean	-2.1	-0.1	3.8	11.7	16.8	21.7	26.1	25.7	19.3	11.9	5.3	-1.6	
Mean Maximum	5.4	5.3	12.3	18.5	20.8	24.1	29.6	28.7	24.0	16.8	12.7	5.3	
Mean Minimum	-9.8	-6.2	-4.2	3.4	12.2	18.3	21.3	20.3	13.3	5.6	-3.2	-9.9	

1/ Period of observation 1963-1973.

2/ Period of observation 1971-1973.

ANNEX 1
Table 1

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Project Works

Dam and Canals

1. The project would provide irrigation facilities for 8,315 ha. Four independent irrigation units, each with its own system of dams and canals, would serve 7,115 ha (Table 1). The remaining 1,200 ha would be irrigated from 22 small dams and five weirs with a typical small dam serving about 50 ha. Details of present and projected land use in areas served by the irrigation facilities are presented in Annex 7, Tables 1-3.

2. Principal features of the four irrigation units are:

Unit	Service Area (ha)	Dams
Kumwang	1,500	Two dams with heights of 20 m and 26 m with a combined storage of 8.8 Mm^3 serving a common canal system.
Maengdong	2,360	A 29 m high dam forming a 9.8 Mm^3 reservior, linked by a 900 m tunnel to a 1.2 Mm^3 diversion reservoir in an adjacent drainage basin.
Baekgok	1,685	An existing 17 m high dam to be raised by 5 m to increase storage from 7 Mm^3 to 17 Mm^3.
Weonnam	1,570	A 25 m high dam storing 7.7 Mm^3 with an 1,800 m tunnel leading to the canal headworks.

The small dams would be from 8 m to 12 m high. Foundation conditions and topography at the damsites favor the construction of fill-type dams. The valleys are fairly wide (crest lengths are between 200 and 300 m), with silts, clays, and gravels overlaying granite which is often weathered to a depth of several meters. All of the dams would be of the embankment type with concrete overflow spillways. The embankment would have a central clay core surrounded by a shell of random fill. The core would be carried down to sound rock and the shell would be placed on weathered granite after removal of unconsolidated overburden. Side slopes and thickness of core would depend on the material available within a reasonable haul

distance. Ample deposits of random fill, often with a fairly high gravel content, are usually found near the sites. Suitable core material is less abundant but can usually be found. Rock and filter material for slope protection is readily available at most sites. Side-channel over-flow spillways without gates would be founded on rock on the abutements. Raising of the Baekgok dam would require converison of the existing siphon to a gated, overflow spillway. Reservoir outlets would be formed by concrete conduits founded on rock. For the areas served by the large dams, about 130 km of main canals and 140 km of laterals would be constructed. Most of the canals would be unlined, but some short sections in permeable soils would be lined with concrete. A number of siphons and tunnels would be needed because of the irregular topography along the canal alignments. Further details of the four irrigation units are given in Table 1.

On-farm Distribution and Land Consolidation

3. The areas to be irrigated are generally narrow strips of land along the river valleys, seldom more than 500 m wide. Because of the relatively short lengths of tertiary canals required, their construction would be left to the farmers who traditionally are willing to join together in such works. Farmland Improvement Associations (FLIA's) would organize farmers to do the work, and farmers would bear the cost. The area involved is 6,865 ha. However, where large blocks of irrigated land extend a considerable distance from the canals, the on-farm distribution systems would be designed and constructed as a part of the project works. This would take the form of land consolidation which consists of a rectangular grid of ditches, roads and drains, with land levelling and boundary realignment over most of the area. Some 1,450 ha would be consolidated.

4. Land consolidation would also be carried out on about 3,150 ha of land which is already irrigated and lies outside of the areas to be irrigated by project facilities. The advantages of land consolidation are that (a) it facilitates mechanical land preparation, (b) it allows easier access to the fields and improved standards of farm management, and (c) it allows more efficient control of irrigation and drainage. The improvements in crop and water management lead to higher rice yields. Also, more timely land preparation combined with effective drainage at the end of the rice growing season facilitate the planting of a winter cereal crop.

5. Land consolidation has been carried out on about 200,000 ha in Korea over the past 20 years. Priority was given to large, flat blocks of land with slopes not exceeding 0.5%. Under these conditions, earth moving quantities were low and uniform standards for the layout of the drains and farm roads were developed. However, land consolidation is now increasingly being carried out where slopes are steeper (0.5-2.0%) and topography is more irregular. Such conditions have been encountered in recent Bank-financed projects 1/ and attempts to follow standard design procedures led initially

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1/ Pyongtaek-Kumgang (Loan 600-KO).
Yong San Gang Stage I (Loan/Credit 795/283-KO).

to excessive earthwork quantities. ADC, its consultants, and Bank staff have devoted considerable attention to the problem. As a result, design principles have been evolved and are being applied which aim at minimizing earthwork quantities by adjusting layout to topography.

Upland Development

6. Conversion of Uplands to Paddy. About 2,045 ha of presently cultivated uplands would be converted to paddy cultivation in areas to be irrigated by the project works. Areas to be converted would be carefully selected to ensure that soils are suited to paddy cultivation and to avoid disturbing orchards and ginseng plantations. The areas to be developed have slopes generally in the range of 5%-10%, and they would be converted into a series of horizontal benches with widths ranging from 20 m to 10 m depending on the slopes. Design and construction techniques for paddy conversion have been developed in the Pyongtaek-Kumgang Project and also in the UNDP/FAO Watershed Project.

7. Furrow Irrigation. A total of 495 ha of upland would be developed for furrow irrigation, of which 410 ha are presently cultivated and 85 ha are uncultivated. These are areas where soils are too shallow to be benched for paddy cultivation. Slopes range from 5% to 15%. Development would consist of land clearing, grading, rearrangements of property boundaries, and construction of tertiary canals, drain and farm roads.

8. Orchards. There are about 550 ha of fairly steep (15-35% slopes) uncultivated land, scattered in small blocks close to the proposed canal alignments. Improved access provided by the canal road and the proximity of an irrigation water supply would provide an incentive for orchard development on these lands. They would be cleared and graded as part of the project, but orchard establishment and facilities to deliver water from the canals would be left to the land owners. The trees would be irrigated only two to three times a year using portable pipes and pumps.

9. Upland Reclamation. About 1,200 ha of uncultivated lands, outside of the areas to be served by the irrigation works, would be developed for rainfed crop production. There are basically three alternative methods of development for upland areas: bench terracing, semi-bench terracing (the area between benches is sloped about 5%), and contour farming with buffer strips and drains. The method to be adopted depends not only on slopes and soil characteristics, but also on the crops to be grown, which in turn are determined by such factors as farm size and proximity to markets. The areas to be developed are covered with small trees and native grasses, and about 500 ha have slopes in the 10-15% range and 700 ha in the 15-20% range. Soils are generally deep and of medium fertility, and suitable for a wide range of upland crops. Under these circumstances, bench terracing is proposed. Designs would be based on detailed topographic and cadastral surveys. In some areas with irregular terrain and dense vegetation, land clearing and rough levelling, to remove mounds and gulleys, would

be carried out prior to the surveys. The geometry of the benches and risers would depend on the original ground slope. Risers are usually limited in height to 1 m, and thus the benches become quite narrow (4 to 8m) on the steeper slopes. Inspection of existing bench terraces constructed by farmers in the project areas, and those constructed elsewhere by the Office of Watershed Development (OWD), shows that surface drainage needs careful attention to avoid excessive erosion. Grassed channels, or channels lined with plastic sheets, appear to be effective, and farmers use plastic sheets on a large scale. OWD has agreed to base their planning and designs for upland reclamation on a report prepared by a Bank consultant. 1/

Channel Improvement

10. Throughout Korea most of the best agricultural land lies in the flood plains of the rivers, and over the years large investments have been made in flood embankments and river training on the larger rivers. However, in the project areas, as in the rest of Korea, lands along many of the smaller rivers remain unprotected.

11. Surveys of the project areas have identified a total of about 80 km of river channels where improvements are needed to protect land and crops from flood damage. Flood embankments, or levees, are the main features of channels protection. Material is excavated from the river channels to construct the levees, and this increases the channel cross-section and hence its conveyance capacity. In some areas the river channels would be straightened to reclaim marginal land bordering the channels. The excavated material (boulders, gravel and sand) would be placed in the levees so that the large boulders would form a protective facing on the channel side of the levee. About 100 km of levees would be constructed for the 80 km of channel improvement, since in some sections a levee is needed only on one side of the channel. Levees would vary in height according to local conditions and would average 2 to 3 m. Except where an existing road runs parallel to the river, the top of the levee would be wide enough to carry a 3.5 m wide gravel road. In constructing a levee, provision would be made to drain the land it protects; a collector drain would be located just inside the levee and drainage culverts with flap gates would be located at intervals of about 400 m.

Access Roads

12. About 150 km of four to five m wide gravel roads would be built to provide access to areas where project works are to be undertaken. In general, the roads would follow existing tracks to minimize land acquisition and would range in length 5 to 10 km. They would generally follow flat terrain, and earth-work would mainly consist of raising the road above the surrounding paddies. Present standards for bank protection and drainage of village

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1/ "Guidelines for Upland Development" Leslie F. Shanan, October 1975.

roads would be used. The roads would be surfaced with 20 cm of crushed stone or river gravel. Culverts would be needed at frequent intervals and allowance has been made in the cost estimate for a 25 m bridge on an average of every 5 km. Bridges would be designed for single-lane traffic only and would normally have a 4.0 m travelled width. The design loading would be the Korean equivalent to the HS-20-44 loading of the American Society of State Highway Officials. Sources of construction material are readily available within short distances of the roads. Bridges would be simple reinforced concrete slab (or beam and slab) construction, with solid piers and abutments. Labor would use simple concrete mixers, powered by hand or small gasoline engines, to mix concrete for bridges or minor structures. Since there are only about 130 km of gravel roads in the project area at present, the proposed roads would significantly improve access from the villages to the main roads leading into the project.

Feasibility Study for Stage II

13. The feasibility study for the second-stage project in the remaining 110,000 ha of the Miho watershed would be carried out by ADC. Primary responsibility would be assigned to OWD whose capacity to carry out such a study was demonstrated in the preparation of the proposed project. A project formulation report based on field surveys, and existing maps and aerial photography, would be prepared by July 1977 and submitted to the Bank for review and comment. This report would identify the principal features of the project; describe requirements for mapping, site investigation, farm surveys and present a work program for completion of the feasibility report by December 1978. Korean consultants, and foreign specialists on short term assignments, would be employed by OWD, to supplement their own staff resources in carrying on the study. In addition to preparation of irrigation and land development components, the study would also include a survey to determine possibilities, for increasing productivity of presently cultivated uplands with particular reference to agricultural extension and credit. Cost estimates for the study are shown in Annex 4.

Surveys and Mapping

14. Aerial photography of the project area to a scale of 1:15,000 was carried out in 1972. This was used for the resource inventory forming a basis for the feasibility report. Photography to a scale of 1:8,000 would be required to prepare maps for land acquisition and for detailed designs. Damsites would be mapped at a scale of 1:1,200 and areas scheduled for land development, reservoirs, and canal alignments would be mapped at 1:3,000. The maps would be prepared by photogrammetry, but ground surveys would be carried out in areas where land development is planned to attain the necessary precision in ground surface elevations. Contractors would be employed for aerial photography, photogrammetry and ground control surveys. ADC surveyors would undertake supplementary ground surveys.

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Proposed Irrigation Facilities

Project Unit:	Kumwang		Maengdong[1/]		Baekgok[2/]	Weonnam[3/]
	Dam I	Dam II	Dam I	Dam II		
Catchment Area (ha)	750	2,110	4,400		8,160	3,840
Annual Runoff (Mm^3)	4.5	13	26		49	23
Live Storage (Mm^3)	2.4	6.4	1.2	9.8	17	7.7
Max. Height of Dam (m)	20	26	7	29	22	25
Crest Length of Dam (m)	240	270	210	230	220	260
Volume of Fill ('000 m^3)	130	260	120	350	130	320
Main Canals (km)	39		29		37	28
Lateral Canals (km)	20		41		18	62
Service Area (ha)						
Paddy	1,300		1,840		1,550	1,460
Upland	-		300		85	-
Orchard	200		220		50	110
	1,500		2,360		1,685	1,570
Right-of-way (ha)						
Paddy	19		65		45	50
Upland	51		78		17	45
Uncultivated	62		61		55	47
	132		204		117	142

1/ Includes a storage dam and a smaller reservoir formed by a 7 m high diversion dam; the two reservoirs would be linked by a 900 m long tunnel.

2/ An existing dam to be raised by 5 m to increase storage capacity by 10 Mm3.

3/ An 1,800 m tunnel would take water from the dam to the canal headworks.

ANNEX 2
Table 1

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Irrigation Facilities Cost
(US$/ha) /1

	Kumwang (1,500 ha)	Maengdong (2,360 ha)	Baekgok (1,685 ha)	Weonnam (1,570 ha)	Small Dams (1,200 ha)	Average Cost (8,315 ha)
Storage Construction	1,086	890	712 /2	752	2,375	1,078
Main and Lateral Canal System	1,593	1,030	1,199	1,561	425	1,179
Land Consolidation /3	1,292	953	855	1,044	988	1,016 /4
Land Acquisition, Road Relocation and Other Compensation	787	581	475	675	517	605
Total - Without Land Consolidation	3,466	2,501	2,386	2,988	3,317	2,862
- With Land Consolidation	4,758	3,454	3,241	4,032	4,305	3,878

/1 Not including contingencies, engineering, supervision and administration.

/2 An existing dam would be raised by 5 m.

/3 Land Consolidation is at the farm level, and consists of a rectangular grid of ditches, roads, drains, and land levelling over most of the area. Only 1,450 ha would be consolidated of the 8,315 ha to be irrigated. Farmers themselves would finance and implement on-farm development on the remaining 6,865 ha.

/4 An average for 1,450 ha only.

ANNEX 2
Table 2

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Water Supply, Demand and Quality

1. The precipitation data shown in Table 1 illustrate the erratic pattern of rainfall during the June-September rice growing season (the crop is usually transplanted in June and harvested early in October). For most of the 11 years of record shown, the rainfall is significantly below crop water requirements in at least one month. Few of the farms in the project area are, however, entirely dependent on direct rainfall since they are usually located in low-lying areas where runoff can be collected from the hillsides or diverted from the rivers. This, combined with skillfull water management by the farmers, tends to even out the extreme fluctuations in rainfall and explains the relatively high yields obtained under adverse climatic conditions. Nevertheless, prolonged droughts inhibit the use of high yielding rice varieties and hold yields of traditional varieties below their potential. Shortage of water can be particularly acute in June for transplanting and land preparation, and prolonged droughts are common in July and August.

2. Annual water requirements for rice for the period 1963-73 are shown in Table 3. Crop consumptive use was estimated by multiplying observed pan evaporation in the project area by crop coefficients based on recent experimental data in Korea (Table 2). Effective rainfall for each month in the growing season was estimated from daily rainfall records. For the period 1963-68, effective rainfall during the growing season averaged 73% of total rainfall. The average irrigation requirement for the period is 5,350 m^3/ha (Table 3).

3. The loss due to seepage and operational waste in the main canals and laterals is estimated at 15%. Below the tertiary outlet the chief source of loss would be deep percolation, which has been allowed for in estimating the farm irrigation requirement. In addition, a loss due to operational waste of 10% in the tertiary systems has been assumed. After taking account of the above losses, the average annual diversion requirement (that is the requirement at the head of the main canal) is 6,990 m^3/ha (Table 3).

4. The lack of streamflow records for the project area made it necessary to estimate runoff for the four irrigation units on the basis of data from similar catchment areas in Korea. These data show that a good approximation of average annual runoff is 6,000 m^3/ha. This relatively high figure, about 50% of the total precipitation, is explained by the steep catchment areas with low infiltration rates (rock to the surface) and by the short intense storms, which produce most of the rainfall.

5. ADC follows conservative policies in the planning of irrigated projects. Nominally the systems are designed to meet full irrigation demands in 9 years out of 10. This is because strict compliance in cost recovery charges can only be expected if farmers have a high degree of confidence in their water supply.

6. Lack of data precluded detailed operation studies to optimize sizing of reservoirs and service areas for the four irrigation units, and it was necessary to rely on judgment supported by operating experience from other storage projects in Korea. A fairly reliable guide is that (a) the catchment area should be no less than twice the area to be irrigated, 1/ and (b) the reservoir capacity should by 30% or more of the annual runoff. Thus, in an average year the unregulated runoff would be 12,000 m^3/ha. A reservoir, therefore, would be required to provide sufficient regulation to utilize about one-half of the runoff in an average year. In a dry year, when runoff is low, a higher degree of regulation would be possible since less water would be spilled during floods. To test the validity of the above criteria, the water supply and demand in the service area of the Kumgang dam were calculated for a critical year 2/ (Table 2). The results shows that the water suppply would adequately meet the paddy requirements. Similar calculations made for the Maendong, Baekgok and Weonnam dams also yielded the same results. The above criteria are therefore valid and the four irigation units, which all meet the above criteria (Table 4), would be able to meet irrigation requirements.

7. There are no water quality data available for the streams in the project area, but crops have been irrigated for many years in the project area without any adverse effects. Soils and parent materials in the watershed bear no toxic elements so it can be assumed that the quality of water is suitable for sustained irrigation.

1/ Assuming, as is usually the case in Korea, that virtually all of the irrigated area is planted to rice.

2/ Year for which rainfall and streamflow are exceeded in nine out of 10 years.

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Monthly Precipitation at Jincheon (mm)

Year

Month	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Jan	-	32	15	3	1	13	100	2	31	86	96
Feb	25	48	18	45	23	15	50	72	42	33	12
Mar	1	53	20	157	58	63	19	10	59	166	1
Apr	139	59	42	35	77	14	187	88	56	106	137
May	252	93	36	64	59	45	130	94	90	115	96
Jun	250	87	61	129	167	51	42	98	265	44	180
July	365	354	694	241	252	196	335	268	436	191	89
Aug	138	474	221	212	243	244	439	136	225	545	177
Sep	23	289	15	239	66	62	251	348	73	144	141
Oct	37	52	24	92	17	120	15	121	11	64	49
Nov	33	28	95	54	91	52	32	28	14	54	54
Dec	32	8	7	19	10	11	20	19	9	6	14
Total	1,295	1,576	1,248	1,288	1,080	884	1,676	1,284	1,310	1,553	1,045

ANNEX 3
Table 1

KOREA

WATER SUPPLY AND DEMAND

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Kumwang Dam Irrigation Requirements (mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
Land Preparation & Nursery 1/						120							120
Transplanting						50							50
Ponding 2/							50						50
Consumptive Use 3/							130	210	150				490
Percolation						40	120	120	120				400
Crop Water Requirement						210	300	330	270				1,110
Rainfall 4/	96	12	1	137	96	180	89	177	141	49	54	14	1,046
Effective Rainfall	-	-	-	-	-	115	65	140	115	-	-	-	435
Irrigation Requirement						95	235	190	155				675
Diversion Requirement 5/						123	305	247	201				876
Irrigable Area (ha)						-------	1,400	----------					
Diversion Requirement (Mm^3)						1.7	4.3	3.5	2.8				12.3
Reservoir Inflow (Mm^3) 6/	1.4	0.2	-	2.0	1.4	2.6	1.3	2.5	2.0	0.7	0.8	0.2	15.1
Change in Storage (Mm^3)	+1.4	+0.2	-	+2.0	+1.4	+0.9	-3.0	-1.0	-0.8	+0.7	+0.8	+0.2	
Storage (Mm^3)	3.1	3.3	3.3	5.3	6.7	7.6	4.6	3.6	2.8 7/	0.7	1.5	1.7	
Spillage (Mm^3) 8/	-	-	-	-	-	-	-	-	-	-	-	-	-

1/ Water required for nursery, soil saturation and replenishment of evaporating water during land preparation.

2/ Depth maintained at 60 mm during growing season.

3/ Derived as follows:

	Pan Evaporation	Crop Coefficient	Consumptive Use
Jul	118	1.1	130
Aug	155	1.35	210
Sep	120	1.25	150

4/ Critical Year Rainfall (total rainfall from June to September is exceeded in nine out of ten years); 1973 rainfall figures are used.

5/ Assumes loss in main canals of 15% and tertiary systems of 10%.

6/ Critical Year Runoff (exceeded in nine out of 10 years); based on runoff coefficient of 0.50.

7/ Available water in reservoir at end of growing season; based on assumption that reservoir was empty at the end of the previous growing season.

8/ No spillage during critical year.

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Annual Water Demands

Year	Crop Water Requirement	Effective Rainfall	Irrigation Requirement	Diversion Requirement
	----------	(mm)	----------	(m^3/ha)
1963	1,110	585	535	6,990
1964	1,110	875	245	3,200
1965	1,110	510	610	7,970
1966	1,110	464	655	8,560
1967	1,110	525	595	7,780
1968	1,110	385	735	9,610
1969	1,110	805	315	4,120
1970	1,110	600	520	6,800
1971	1,110	685	435	5,690
1972	1,110	560	560	7,320
1973	1,110	440	680	8,890
		Average	535	6,990

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Water Supply and Demand

	Kumwang	Maengdong	Baekgok	Weonnam
Catchment Area (ha)	2,860	4,400	8,160	3,840
Average annual runoff (Mm^3)	17.5	26	49	23
Reservoir Storage (Mm^3)	8.8	11	17	7.7
" " (m^3/ha)	6,280	5,640	5,090	5,270
Irrigated Area (ha)			(1,750) 1/	
Paddy	1,300	1,840	1,550	1,460
Upland	200	520	135	110
Paddy equivalent 2/	1,400	2,100	3,370	1,520
Catchment Area / Irrigation Area	2.0	2.1	2.4	2.5
Storage / Average Annual Runoff	.5	.42	.35	.33

1/ Area presently irrigated.

2/ Assumes requirement for 2 ha of upland equals requirement for 1 ha of paddy.

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Cost Estimates

1. Designs of the dams and canals to serve the four independent irrigation units are in sufficient detail for quantity estimates. OWD used a standard government procedure to estimate unit prices for each work item. This procedure is set out in a handbook published by the Government in January of each year. For a wide range of construction activities, the handbook provides labor and equipment inputs; prices for labor, materials and equipment; and various coefficients and factors to be employed in the estimating process. The unit prices computed for the project works take into account the revision to basic prices published by the Government through November 1975 and therefore can be considered as representing January, 1976 price levels. The computed prices are in line with unit prices (adjusted for price escalation) quoted by contractors for ongoing Bank-financed projects. A check of the OWD quantity estimates showed them to be adequate. Costs for the small dams and canals are based on preliminary designs for three typical schemes; a net construction cost of Won 1,360,000 (US$2,800) per ha was used.

2. Construction costs for conversion of uplands to paddy, and for land consolidation are based on recent (October 1975) bid prices for similar work on the Pyongtaek-Kumgang and Yong San Gang Projects. The construction cost for bench-terracing of uncultivated upland is based on a recent study by a Bank consultant (Annex 2). For cultivated uplands developed for furrow irrgation, and for development of uncultivated land for orchards, the construction cost estimates are based on OWD's experience under similar conditions elsewhere in Korea. Construction costs of access roads and channel improvements are based on preliminary designs for sample sections. Physical contingengies amount to 15% of the net construction cost. Engineering and administration costs are 10% of the net cost plus physical contingencies.

3. OWD has surveyed the areas to be inundated by the reservoirs and the land to be acquired for construction of project works. Unit costs for land acquisition, in January, 1976 prices are:

	Won M/ha	US$/ha
Paddy	4.7	9,700
Cultivated Upland	2.5	5,150
Uncultivated Upland	0.8	1,650

Compensation would also be paid for houses and farm buildings and also for the removal and relocation of graves. These costs would, however, be small in relation to costs for land acquisition.

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Cost Estimate

	Local	Foreign	Total	Local	Foreign	Total	Foreign Exchange	Of Base Cost
	(Won million)			(US$'000)			(%)	(%)
Dams and Canals	5,230	4,280	9,510	10,790	8,830	19,620	45	45
Land Development								
Conversion of Uplands	850	700	1,550	1,740	1,440	3,180	45	7
Land Consolidation	1,240	1,010	2,250	2,580	2,070	4,650	45	11
Upland Development	410	330	740	850	680	1,530	45	4
Furrow Irrigation	150	130	280	310	270	580	45	1
Orchards	140	110	250	290	220	510	45	1
Channel Improvement	380	310	690	780	640	1,420	45	3
Access Roads	400	320	720	820	660	1,480	45	4
Surveys and Mapping	120	270	390	250	550	800	70	2
Technical Assistance	20	50	70	40	100	140	70	-
Vehicles	10	30	40	20	60	80	70	-
Feasibility Study Stage II	220	220	440	450	460	910	50	2
Right-of-Way	2,330	0	2,330	4,810	0	4,810	0	11
Engineering & Administration	1,610	300	1,910	3,330	610	3,940	15	9
Base Cost Estimate	13,110	8,060	21,170	27,060	16,590	43,650	38	100
Physical Contingencies	1,440	860	2,300	2,950	1,800	4,750	38	11
Expected Price Increases	7,760	5,140	12,900	15,990	10,610	26,600	40	61
Total Project Cost	22,310	14,060	36,370	46,000	29,000	75,000	39	172

ANNEX 4
Table 1

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Cost Estimates

Dams and Canals
(US$'000)

	Kumwang		Maengdong		Baegkok	Weonnam	Small Dams	Totals
	Dam I	Dam II	Dam I	Dam II				
Dams	390	660	1,450	70	290	570	1,920	5,350
Spillway & Outlet	210	370	400	180	910	610	930	3,610
Canals	-	2,390	2,220	210	2,020	2,450	510	9,800
Road relocation	50	520	-	70	80	140	-	860
Sub-total	650	3,940	4,070	530	3,300	3,770	3,360 /1	19,620
Physical contingencies	100	390	610	80	500	570	500	2,750
Land acquisition	160	360	690	460	660	870	600	3,800
Other compensation	30	60	90	60	60	50	20	370
Engineering & administration	90	500	470	70	450	520	290	2,390
Total	1,030	5,250	5,930	1,200	4,970	5,780	4,770	28,930

/1 Estimated assuming US$2,800/ha cost.

ANNEX 4
Table 2

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Cost Estimates

Land Development

Type of Development	Area (ha)	Slopes (%)	Unit Cost (US$/ha)	Base Cost	Contin-gencies	Engineering & Administration	Total /1	Average Cost per ha
				(US$'000)				(US$/ha)
Conversion of uplands to paddy	455	0-5	1,300	590	90	70	750	1,645
	1,340	5-10	1,600	2,140	320	250	2,710	2,025
	250	10-15	1,800	450	70	50	570	2,275
Sub-total	2,045			3,180	480	370	4,030	1,970
Land consolidation	3,800	0-1	950	3,610	540	420	4,570	1,200
	800	1-2	1,300	1,040	150	120	1,310	1,645
Sub-total	4,600			4,650	690	540	5,880	1,280
Upland Development (Irrigated)	300	5-10	1,130	340	50	40	430	1,430
	195	10-15	1,240	240	30	30	300	1,570
Sub-total	495			580	80	70	730	1,485
Upland Reclamation	80	5-10	930	70	10	10	90	1,175
	440	10-15	1,150	510	80	60	650	1,455
	680	15-20	1,400	950	140	110	1,200	1,770
Sub-total	1,200			1,530	230	180	1,940	1,615
Upland Development (Orchards)	550	15-35	930	510	80	60	650	1,180
TOTAL				10,450	1,560	1,220	13,230	

/1 Rounded to nearest US$10,000.

ANNEX 4
Table 3

ANNEX 4
Table 4

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Cost Estimates

Channel Improvement

Construction Cost per km of Levees (US$)

	Large Channels	Small Channels
Earthwork	13,600	7,200
Slope protection	4,350	2,050
Drainage culverts	1,550	1,050
Miscellaneous	300	200
	19,800	10,500
Right-of-way	5,150	2,050

Total Costs (US$'000)

Large channels (40 km)	790
Small channels (60 km)	630
Sub-total	1,420
Physical contingencies	210
Engineering and administration	160
Sub-total	1,790
Right-of-way	330
Total	2,120

Note: Material excavated from the channels would be used for construction of the flood embankments. The above costs include excavation and placing of material.

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Cost Estimates

Village Access Roads

		Cost/km (US$)	Amount 1/ (US$'000)
Earthwork		2,470	370
Gravel Surfacing		2,680	400
Culverts		2,890	430
Bridges		30 @ US$ 9,300 each	280
	Subtotal		1,480
	Physical Contingencies		230
	Engineering & Administration		170
	Sub-total		1,880
	Right-of-way		310
	Total		2,190

1/ Based on 150 km of roads.

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Cost Estimates

	US$'000
A. Surveys & Mapping	
Aerial photography	80
Map preparation	370
Ground control	80
Field surveys	270
Sub-total	800
B. Feasibility Study Stage II	
Aerial photography and mapping	250
Site investigations	40
Socioeconomic surveys	50
Planning & design (ADC)	250
Planning & design (consultants)	210
Specialist advisors	60
Vehicle operations	30
Miscellaneous	20
Sub-total	910
Total	1,710

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Expected Price Increases

	Calendar Year						
	1976	1977	1978	1979	1980	1981	Total
Civil Works /1	-	1,660	9,270	13,420	10,460	7,720	42,530
Annual Inflation Rate (%)	15	12	12	12	10	10	
Expected Price Increases /2	0	360	3,380	7,100	7,290	6,690	24,820
Services & Equipment /3	240	940	1,510	1,650	910	620	5,870
Annual Inflation Rate (%)	10	8	8	8	7	7	
Expected Price Increases /2	-	140	350	550	400	340	1,780
Total Expenditures without Price Increases	240	2,600	10,780	15,070	11,370	8,340	48,400
Total Expected Price Increases	-	500	3,730	7,650	7,690	7,030	26,600
Total Expenditure with Price Increases	240	3,100	14,510	22,720	19,060	15,370	75,000

/1 Civil works include dams & canals; land development; channel improvement; access roads; and right-of-way. Civil works cost include price contingencies. See Annex 5, Table 1 for yearly expenditures on each item.

/2 Calculated by compounding rate of price increase in prior years and one-half the rate of increase in the year concerned.

/3 Services & equipment include surveys and mapping; technical assistance; vehicles; feasibility studies; and engineering and administration. See Annex 5, Table 1 for yearly expenditures of each item.

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Estimated Schedule of Expenditure

	Total	1976[/1]	1977	1978	1979	1980	1981
				(US$'000)			
Dams and Canals	22,370	-	820	2,920	6,250	6,970	5,410
Land Development	12,010	-	440	1,880	3,890	3,490	2,310
Channel Improvement	1,630	-	-	720	910	-	-
Access Roads	1,710	-	-	1,240	470	-	-
Right-of-Way	4,810	-	400	2,510	1,900	-	-
Surveys and Mapping	800	100	200	290	210	-	-
Technical Assistance	140	40	60	40	-	-	-
Vehicles	80	-	80	-	-	-	-
Feasibility Studies: Stage II	910	-	100	270	540	-	-
Engineering and Administration	3,940	100	500	910	900	910	620
Sub-total	48,400	240	2,600	10,780	15,070	11,370	8,340
Expected Price Increases	26,600	-	500	3,730	7,650	7,690	7,030
Total Project Cost	75,000	240	3,100	14,510	22,720	19,060	15,370

/1 Calendar years, which correspond to Korean financial year.

ANNEX 5
Table 1

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Estimated Schedule of Disbursements

IBRD Fiscal Year and Semester	Accumulated Disbursements --(US$ '000 Equivalent)--
Fiscal Year 1977	
1st	0
2nd	100
Fiscal Year 1978	
1st	200
2nd	1,200
Fiscal Year 1979	
1st	3,400
2nd	7,000
Fiscal Year 1980	
1st	11,000
2nd	16,000
Fiscal Year 1981	
1st	20,400
2nd	23,600
Fiscal Year 1982	
1st	26,800
2nd	29,000

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Proposed Allocation of Loan Proceeds

	Category	Costs Total	Costs Foreign	Proposed Loan
		(US$ million)		
I.	Civil Works:			
	Base Cost /1	28.50	11.70	
	Expected Price Increases	19.00	7.80	19.0
	Sub-total	47.50	19.50	
	Disbursements will be 40% of total expenditures.			
II.	Equipment and Materials:			
	Cement	2.00	1.00	
	Steel	2.50	2.00	
	Vehicles	0.08	0.08	
	Expected Price Increases	3.42	2.42	5.5
	Sub-total	8.00	5.50	
	Disbursement will be 100% of foreign expenditures for directly imported equipment, 65% of expenditure (ex-factory) for locally manufactured equipment and materials.			
III.	Consulting Services:			
	Consultants	0.14	0.14	
	Survey and Mapping	0.80	0.58	
	Feasibility Study	0.91	0.46	
	Expected Price Increases	0.55	0.42	1.6
	Sub-total	2.40	1.60	
	Disbursements will be 100% of foreign expenditures or 65% of local expenditures.			
IV.	Unallocated:			
	Physical Contingencies	4.75	1.70	2.9
	(Right-of-Way)	(4.81)	-	
	(Engineering and Supervision)	(3.94)	(0.52)	
	(Expected Price Increases)	(3.60)	(0.18)	
	Total	75.00	29.00	29.00

/1 Includes Dams and Canals US$19.62 million; Land Development US$10.45 million; Channel Improvement US$1.42 million; Village Access Roads US$1.48 million; Less Cement and Steel US$4.5 million.

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Supporting Agricultural Services

1. The Ministry of Agriculture and Fisheries (MAF) supervises all agricultural services in Korea. Each provincial government has an Agriculture and Forestry Bureau, which administers MAF functions in the province. The main agencies which would serve the proposed project, apart from ADC, are the Office of Rural Development (ORD) and the National Agricultural Cooperative Federation (NACF).

2. The project area is practically all (96%) within the province of Chungcheong Bug, with the provincial administration at Cheongju. The remainder of the project area lies in Gyeonggi province.

Research and Extension

3. ORD is in charge of research, extension, and training. The following agencies of ORD are located at its headquarters in Suweon, 25 km south of Seoul:

The ORD Headquarters;
Crop Improvement Station (breeding and agronomy of field crops);
Horticultural Research Institute (vegetables and fruits);
Institute of Plant Environment (soil survey, fertilizers, liming and pest control);
Guidance Bureau (extension);
Training Burea (for extension workers); and
Farm Machinery Training Center.

The research institutes and the Guidance Bureau are staffed adequately.

4. Each province has a provincial ORD which carries out local experimentation, field demonstrations, multiplication of foundation seeds and extension, and each county has five to ten branch offices. Workers in these offices form the main force of agricultural extension.

5. The provincial ORD at Cheongju is responsible for research and extension in the project area. It is well coordinated with the national research and extension worker training programs at Suweon. Research in the province is currently aimed at crop yield improvement, earlier maturing varieties, and disease or insect resistance. Trials or plots at the county level may be part of a research effort, but usually they are designed to demonstrate new or proven practices to the farmers. These are useful, well conducted demonstrations. The experimental and demonstration results are well documented. Extension pamphlets and posters are adequate for current

extension needs of irrigated or rainfed rice, rainfed barley and other crops. The four counties included in the project area have 145 extension workers to serve about 75,000 ha of farms, averaging about one worker to 500 ha. The existing extension system works satisfactorily as is evidenced by the relatively high yield levels even under existing rainfed conditions. With the project, farmers would require guidance in irrigation of barley, and use of lime on upland areas.

Farmers' Organization

6. Two types of farmers' organization operate in the project area. Those associated with irrigation, such as Farm Land Improvement Associations (FLIA's); and those with credit or input supplies, such as the NACF. Three FLIA's are already operating in the irrigated areas. They are self-supporting, and their responsibilities are:

(a) to operate and maintain irrigation and drainage facilities, including the collection of O & M fees;

(b) through extension and training, to assist members increase production; and

(c) to carry out land consolidation works and to collect the repayments on the loans for these works.

With the project, several small irrigation systems would be constructed in isolated areas. These would be operated by Water User Groups or Hung Nong Gaes (HNG's). ADC would establish these groups, which may in time become big enough to form FLIA's, or join with existing FLIA's.

7. Almost all supplies of inputs and credit originating from Government sources are supplied through the cooperative system. It also handles marketing of a number of crops. Over 90% of project area farmers are members of district cooperatives. These primary cooperatives are successively grouped into county agricultural cooperative federations, which are part of NACF.

8. Although NACF is the apex of the rural cooperatives, it actually functions as a Government trading and banking agency. The president of NACF is appointed by the President of Korea, and the managers of the provincial NACF and county cooperatives are in turn appointed by the NACF President. Not only do the cooperatives serve in channeling Government supplied inputs and credit to farmers, they also make the farmers' needs known to the Government.

Fertilizer

9. Annual fertilizer consumption in the project area is currently some 2,950 nutrient tons, consisting of 1,370 tons nitrogen; 840 tons phosphoric acid; and 740 tons potash. Application rates of all fertilizers average 0.23 nutrient ton per ha per year. Additionally, 80 tons of lime are applied to 370 ha each year. Farmers also apply large amounts of compost (up to 6 ton/ha) to each rice crop. At full development the project would require some 5,500 nutrient tons of fertilizer annually, consisting of 2,520 tons of nitrogen; 1,580 tons of phosphoric acid; and 1,400 tons of potash. As well, 1,560 tons of lime would be required for uplands crops. NACF currently supplies all fertilizers through the village cooperative depots in the project area, and would be able to handle easily the projected increased demand.

Seed

10. Approximately 420 tons of rice seed and 170 tons of barley seed are currently used in the project area. About 95% of the seed is obtained by retention from the farmers' commercial production, and 5% from seed-growers. The Chungcheong Bug provincial ORD multiplies foundation seed to produce registered seed at the ORD seed farm in Cheonju. Selected seed growers in the villages then use the registered seed to produce certified seed, which they sell to farmers. Under this system, seed growers multiply rice, barley, wheat, soybean, and potato seed. While seed supply has not been a constraint under this system, quality maintenance has been. The Bank is presently assisting with the establishment of a new national system for quality seed supply (Loan 942-KO). This would insure future adequate supplies of quality seeds in the project area. At full development the project would use approximately 500 tons of rice seed and 520 tons of barley seed per year. On the assumption that rice and barley seed would be renewed every five crop seasons, the estimated annual requirement of quality seed at full project development would be 100 tons rice and 100 tons barley.

Credit

11. An estimated 15% of project area farmers finance their requirements of farm inputs and hired labor from their own resources. The remainder use credit from the NACF, money lenders, millers or relatives. The NACF supply approximately 50% of the farmers' production credit needs, providing six-month loans at 1% interest per month. NACF's annual production loans in the area amount to some Won 430 million (US$0.9 million). Credit from other sources is usually much more expensive, with money lenders charging 3%-5% interest per month.

12. Assuming that at full project development 15% of the farmers would finance their farm inputs and hired labor requirements from their own resources, approximately 8,800 farmers would require credit. At a loan level of Won 100,000/ha the total annual credit requirement would be Won 1,070 million

(US$2.21 million). The NACF project area operations would have to expand by 150% to supply this sum. Administratively there should be no difficulties in handling the increased volume of credit provided the funds are made available. Assuming 750 8-10 hp power tillers and 200 15 ton/hr mechanical threshers are required in the project area, farmers or contractors would need US$2.2 million credit to purchase them.

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Present and Projected Cropping Patterns and Production

Present Cropping Pattern

1. Situated in the central region of Korea, the project area has a 180-190 day frost-free period. The main crop rice, plus oilseeds, vegetables, tobacco and red peppers, are grown during the summer. Barley is sown in autumn, remains dormant during the winter, and is harvested in late spring - early summer. Of the 12,665 ha to be developed, 8,375 are now sown to rice; 2,455 ha are sown to the minor summer crops; 1,200 ha are forest; and 635 ha are uncultivated upland. Approximately 3,150 ha of rice are irrigated from small dams or weirs. The balance of the rice area (5,225 ha) and all other crops are rainfed. Rice is mainly grown on the valley floors or lowlands, while the other summer crops are concentrated on the valley slopes or uplands. Barley (1,820 ha) is grown on both areas, on some 20% of the riceland and 40% of the upland. The overall project area cropping intensity is 117%. Tables 1 and 2 show the cropping patterns and production estimates at present, and in future without the project.

2. Rice is grown between May and October. Providing sufficient rain has fallen, or irrigation is available, farmers transplant in the second and third weeks of June. If transplanting is delayed, rice yields are reduced. The longer the delay, the greater the yield reduction and interference of late rice harvesting with barley sowing. All rice is transplanted from field nurseries onto previously puddled land. Harvesting is usually in late September - October. Other summer crops are sown March to May, with some double cropping of vegetables possible. Barley is sown after the rice as soon as the seedbed is dry enough for preparation (mid-October to mid-November). Harvesting is in late May or the first half of June.

3. Rice HYV's are sown on 40% of the irrigated area, compared to 10% of the rainfed area. The average yield for all varieties of rice is about 3.1 ton/ha of polished rice (assuming a 68% milling percentage) under irrigation, and 2.7 ton/ha under rainfed conditions. Regular or common barley seed is sown, with an average yield of 2.0 ton/ha. Soybeans and sesame are the most important oilseed crops grown, while the vegetables crops are mainly white potato, sweet potato and chinese cabbage. Other crops of importance are red peppers and tobacco. The forest and uncultivated upland produce fuelwood. Table 5 gives all present and future crop yields.

Future Cropping Pattern

4. Without the project, varietal improvement and better pest control would increase most crop yields (Table 2). The percentage of rice HYV's would increase to 80% on irrigated land and 20% on rainfed. Irrigated rice yields would average 3.9 ton/ha; rainfed rice 2.9 ton/ha. Due to greater government extension efforts, 950 ha of barley grown on presently irrigated rice land would be irrigated. Irrigated barley would average 2.4 ton/ha and rainfed barley 2.2 ton/ha. Barley areas would also increase on both the rice land and upland to lift overall cropping intensity to 126% in the project area.

5. Table 3 shows the expected changes in cropping pattern and production with the project. Some 8,315 ha would be provided with irrigation increasing the net irrigated area to 11,465 ha. In doing this, about 2,045 of cultivated uplands would be developed for paddy production; 4,600 ha of rice lands consolidated; 550 ha of uncultivated upland developed for orchards; and 495 ha of cultivated upland developed for furrow irrigation. Irrigated rice would be grown on a net 10,420 ha; irrigated red peppers, tobacco and vegetables on a net 550 ha. Rainfed upland production would be on a net 1,200 ha, developed from forest land. On the irrigated area, a second vegetable crop and barley would increase the cropping intensity to 137% per year. On the rainfed area, a barley crop would increase the cropping intensity to 145%. The overall project area cropping intensity would be 138%.

Future Yields

6. With good water control, adequate supplies of credit, inputs and extension service, estimated future crop yields under irrigation would average: polished rice, 4.5 ton/ha;1/ barley 2.6 ton/ha; red peppers, 1.5 ton/ha; tobacco, 2.5 ton/ha; vegetables, 23.6 ton/ha; 2/ and orchards, 35.6 ton/ha. 3/ The projected yields would be achieved five years after the introduction of water, or completion of land consolidation on areas already irrigated. Rainfed crop yields would be similar to those projected for the future without the project.

7. With irrigation, improved crop yields would be assisted by the use of the most suitable varieties; better land preparation through greater use of machinery; heavier fertilizer inputs; and greater expenditure on crop protection and weed control. Rice HYV's would spread to 90% of the rice area

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1/ Composite rice yield for 4,600 ha consolidated at 4.8 ton/ha; 5,820 ha non-consolidated at 4.2 ton/ha.

2/ Composite vegetable yield for 30% of area white potato at 20 ton/ha; 70% of area chinese cabbage at 25 ton/ha.

3/ Composite orchard yield for 70% of area apples at 40 ton/ha; 30% of area pear at 25 ton/ha.

(100% of land-consolidated area; 80% of rest). Land consolidation would allow a greater use of machinery, and channel improvement would reduce possible flood losses. The improved village roads would allow better access from villages to market, thus facilitating the inflow of inputs and outflow of produce.

8. At full project development estimated rice production would average 46,500 tons, an increment of 19,500 tons over estimated future production without the project. Similarly, estimated barley production would be 12,500 tons, an increment of 6,000 tons; and upland crops, 36,800 tons, an increment of 20,800 tons.

Development Constraints

9. The project would bring an increased cropping intensity; a 30% increase in labor requirement; an increase in mechanized land preparation and threshing; and a demand for more fertilizer, agro-chemicals, and facilities for drying, storage and processing. The most important issues are examined briefly.

10. Cropping Calendar. Chart No. 15824 shows the typical annual cropping activities in the project area. Two critical periods occur during the cropping season. The first is in June, when barley has to be harvested so that rice can be transplanted; the second in October, when rice must be harvested as quickly as possible so that barley can be sown early enough to be established well before the onset of heavy frosts. With irrigation, both the rice and barley crops can be planted at the correct time, thus avoiding yield reductions due to late planting, and interference with the following crop. Land consolidation would also improve drainage on ricelands, thus increasing the area which can be double cropped to barley.

11. Labor Availability. The labor supply is at present a constraint during the "barley harvesting-rice transplanting," and "rice harvesting-barley planting" periods. With the project, the increased cropping intensity and production would substantially increase annual labor demand. In addition, the number of agricultural workers in the area has been declining over recent years. Land consolidation, which would facilitate mechanization of land preparation, threshing and hauling, would help to offset this problem. In addition, rice and barley varieties are being bred for earlier maturity. This would increase the time available at the critical harvest and planting periods, thus easing peak labor demands.

12. Mechanization. About 10% of land preparation is now done by power tillers, the balance by animal drawn implements. There are few four-wheel tractors available. With land consolidation, improved water management, and better access to fields under the project, power tillers and some four-wheel tractors would be used for an estimated 70% of rice land preparation; 80%-90% of barley and 100% of other upland crop land preparation. Rice and barley are cut by hand and either stacked in the fields awaiting threshers,

carried to threshers or threshed by hand in the field. At present, 25% of rice and barley are mechanically threshed with the drum-loop type. These are usually linked with the power take-off on the power tiller. The use of the power threshers is rapidly increasing and it is estimated that 70% of rice and 90% of the barley would be threshed mechanically in the future. The use of machine powered sprayers is also increasing rapidly, and this is expected to continue in the future.

13. Drying, Storage and Processing. Farmers have sufficient sun drying areas in their villages or at their farms to handle the present crops. These can be easily expanded for the expected production increase. On the other hand, farmers have limited rice and barley storage capacity. NACF has some warehouses in the project area, but plans to build more under a national warehouse building program. NACF's planned storage capacity would be sufficient to handle the expected production increases in the project area. Rice and barley mills are mainly privately owned, and have sufficient capacity to handle the present crop. However, additional milling capacity would be required at full project development. This would be provided either by the private sector, or by the Government through the NACF.

Marketing

14. Over 90% of project areas farmers belong to district or county cooperatives, and thus can sell their surplus produce through the NACF. Nevertheless, most farmers sell to private traders. These traders are usually small scale with inadequate financing and deficient facilities. The market channels are diverse and frequently include many middlemen. Government policy is to improve marketing channels by means of increased financial support for the cooperative organizations, particularly NACF. The government role in marketing is of considerable importance because it is involved in the implementation of price policy for farm inputs and produce, the encouragement of exports and the procurement of farm produce for government use. NACF presently markets some 25% of agricultural produce. The Government plans to increase this percentage in the future, and to increase the range of NACF's marketing services, including modernizing processing and storage facilities.

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Present Production from Project Area

	Area (ha)	Yield (ton/ha)	Farm Gate Price (Won'000/ton)	Gross Value of Production	Production Cost 1/	Net Value of Production	Net Return from Project Area (Won million)
				(Won'000/ha)			
Irrigated:							
Rice	3,150	3.1	266	825	136	689	2,170
Rainfed:							
Rice	5,225	2.7	266	718	132	586	3,062
Barley 2/	1,820	2.0	131	262	91	171	311
Red Pepper	170	1.3	1,215	1,580	153	1,427	243
Tobacco	200	2.1	784	1,646	198	1,448	290
Oil Seeds 3/	1,230	0.7	266	186	44	142	175
Vegetables 4/	860	15.2	50	760	160	600	516
Uncultivated Forest 5/	1,835	2.5	13	33	-	33	61
Sub-total	11,340						4,658
Total	14,490						6,828

Cropping Intensity 6/ = 117%

1/ Based on Annex 8, Table 1; excludes cost of labor.

2/ Barley is grown during winter on 10% of lowland and on 40% upland.

3/ Includes by area soybeans 70%; sesame 30%.

4/ Includes by area white potato 28%; sweet potato 34%; chinese cabbage 38%.

5/ Forest produces fuel wood.

6/ Based on a net cultivable area of 10,830 ha (riceland 8,375 ha; upland 2,455 ha), but not including forest.

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Projected Production Without the Project

	Area (ha)	Yield (ton/ha)	Farm Gate Price (Won'000/ton)	Gross Value of Production	Production Cost 1/ (Won'000/ha)	Net Value of Production	Net Return from Project Area (Won million)
Irrigated							
Rice	3,150	3.9	232	905	124	781	2,460
Barley 1/	950	2.4	131	314	87	227	216
Sub-total	4,100						2,676
Rainfed							
Rice	5,225	2.9	232	675	118	555	2,900
Barley 1/	1,890	2.2	131	288	81	207	391
Red Pepper	170	1.3	1,215	1,680	125	1,455	247
Tobacco	200	2.1	784	1,646	168	1,478	296
Oil Seeds 2/	1,230	0.9	288	259	40	219	269
Vegetables 3/	860	16.6	50	830	132	698	600
Uncultivated Forest 4/	1,835	2.5	13	33	-	33	61
Sub-total	11,410						4,764
Total	15,510						7,440

Cropping Intensity 5/ = 126%

1/ Based on Annex 8, Table 2; excludes cost of labor.

2/ Includes by area soybeans 70%; sesame 30%.

3/ Includes by area white potato 28%; sweet potato 34%; chinese cabbage 38%.

4/ Forest produces fuel wood.

5/ Based on a net cultivable area of 10,830 ha (riceland 8,375 ha; upland 2,455 ha), but not including forest.

ANNEX 7
Table 2

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Projected Future Production With the Project at Full Development

	Area (ha)	Yield (ton/ha)	Farm Gate Price (Won'000/ton)	Gross Value of Production	Production Cost 1/ (Won'000/ha)	Net Value of Production	Net Returns from Project Area (Won million)
Irrigated							
Rice 2/	10,420	4.5	232	1,044	143	901	9,388
Barley	4,245	2.6	131	341	101	240	1,019
Red Peppers	100	1.5	1,215	1,823	144	1,679	168
Tobacco	100	2.5	784	1,960	191	1,769	177
Vegetables 3/	375	23.6	45	1,062	185	877	329
Orchard 4/	550	35.6	114	4,058	800	3,258	1,792
Sub-total	15,790						12,873
Rainfed							
Barley 2/	600	2.4	131	314	99	215	129
Red Peppers	145	1.3	1,215	1,580	136	1,444	209
Tobacco	50	2.1	784	1,646	174	1,472	74
Oil Seeds 5/	540	0.9	302	272	51	221	119
Vegetables 6/	410	17.0	52	884	113	771	316
Sub-total	1,745						847
Total	17,535						13,720

Cropping Intensity 7/ = 138%

1/ Based on Annex 8, Table 3; excludes cost of labor.

2/ Composite rice yield of 4.8 ton/ha on 4,600 ha consolidated; 4.2 ton/ha on 5,820 ha non-consolidated.

3/ Includes by area white potato 30%; chinese cabbage 70%.

4/ Includes by area apples 70%; pears 30%.

5/ Includes by area soybeans 65%; sesame 35%.

6/ Includes by area white potato 20%; sweet potato 60%; chinese cabbage 20%.

7/ Based on a net cultivable area of 12,665 ha (riceland 10,420 ha; upland 2,245).

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Summary of Cropping Pattern & Production

	Cropped Area		Crop Production[1/]	
	Present	Future	Present	Future
	ha		(ton)	
Irrigated				
Rice	3,150	10,420	9,800	46,900
Barley	-	4,245	-	11,000
Red Pepper	-	100	-	200
Tobacco	-	100	-	300
Vegetable	-	375	-	8,900
Orchard	-	550	-	19,600
Sub-total	3,150	15,790		
Rainfed				
Rice	5,225	--	14,100	-
Barley	1,820	600	3,600	1,400
Red Pepper	170	145	200	200
Tobacco	200	50	400	100
Oil Seed	1,230	540	900	500
Vegetable	860	410	13,100	7,000
Uncultivated Forest	1,835	-	4,600	-
Sub-total	11,340	1,745		
Total	14,490	17,535		
Cropping Intensity[2/]	117%	138%		

1/ Production rounded to nearest 100 ton.

2/ For net cultivable area, see Tables 1 and 3.

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Present and Projected Yields

Crops	Yields (tons/ha)						
	Present		Future Without Project		Future With Project		
	NI	I	NI	I	NI	I 1/	
Traditional Rice	2.7	3.0	2.8	3.3	-	3.5	
HYV Rice	3.1	3.4	3.3	3.8	-	4.4	(4.8) 2/
Barley	2.0	-	2.2	-	2.2	2.4	(2.8) 2/
Oil Crops:							
Soybeans	0.8	-	1.0	-	1.0	1.3	
Sesame	0.5	-	0.6	-	.6	0.8	
Vegetable Crops:							
White potato	12.0	-	14.0	-	14.0	20.0	
Sweet potato	17.0	-	18.0	-	18.0	25.0	
Chinese cabbage	16.0	-	17.0	-	17.0	25.0	
Red Pepper	1.2	-	1.3	-	1.3	1.6	
Tobacco	2.0	-	2.1	-	2.1	2.5	
Apples	-	-	-	-	-	40.0	
Pears	-	-	-	-	-	25.0	
Forest	2.5 3/	-	2.5 3/	-	-	-	

(All rice and barley yields are on polished basis)

1/ NI = non-irrigated, I = irrigated.

2/ With land consolidation.

3/ Tons of fuelwood per year.

Note: Yields for oil and vegetables crops appearing in Table 1, 2 and 3 are weighted averages combined from the above individual crop yields.

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Crop and Farm Budgets

1. Annex 7 contains the existing and proposed cropping patterns. This annex shows:

(a) Production costs for irrigated and rainfed crops at present and in the future "with" and "without" the project (Tables 1-3). Present production costs are based on the results of surveys conducted by OWD, and interviews in the area during appraisal. In the future without the project, fertilizer inputs would increase moderately (6% to 10%), and agro-chemical use considerably (20% to 60%). Mechanization would be introduced to rice and barley crop land preparation, and the mechanical threshing of these crops would increase. Future input levels for "with project" conditions are based on recommendations by the Office of Rural Development, and observed shifts to mechanized cultivation, threshing and input-output hauling when irrigation and land consolidation are provided. Table 4 shows assumed input quantities used in the present and future situations:

(b) Crop budgets for the present and for the future "with" and "without" the project (Table 5). Prices used for rice, barley and tobacco are actual government purchase prices. As prices for other crops are subject to severe seasonal fluctuation, prices used were an average of farm gate prices over 1970-75 adjusted for inflation; and

(c) Farm budgets for typical family farms of 0.5 ha, 1.5 ha and 2.5 ha (Table 6). The budgets are calculated according to cash flows. Labor costs include only hired labor, not farm family labor, and were determined by calculating the excess of total monthly labor requirements over an estimated 45 man-days of family labor per farm per month. Hired farm labor is costed at Won 1,600 per day. At present the entire area of small farms (0.5 ha) is under cultivation, and consisting of 80% riceland and 20% upland. The 1.5 ha and 2.5 ha farms include some forest or uncultivated upland (near 20%) about 60% riceland and 20% cultivated upland. With the project, the 0.5 ha farms would be entirely under irrigation, while the 1.5 ha and 2.5 ha farms would have irrigation facilities for nearly 90% of their net cultivable area. The remaining 10%

would be rainfed. Uncultivated forest suitable for development, would be brought into production for upland crops. In addition, the 0.5 ha farm would have slightly higher cropping intensities than the 1.5 ha and 2.5 ha farms. With the project, farmers would pay full O & M costs, estimated at Won 27,650 (US$57)/ irrigated ha. They would also repay part of the project's capital costs; calculated for irrigation works as 30% of capital costs over 35 years at 3.5% interest per year, with an initial five-year grace period followed by 30 years of repayments; and for upland reclamation as 30% of capital costs over eight years at 9% interest per year. Farmers also pay taxes on riceland equivalent to 6% of gross value of production after deducting 1.4 ton of foodgrain, and on upland,6% of gross value of production after deducting Won 85,000 per ha.

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Crop Production Costs: Present[1/]

Cash Inputs (Won'000/ha)[2/]	Rice				Barley		Oil Seeds		Vegetables		Red Pepper		Tobacco		Forest
	Rainfed		Irrigated		Rainfed		Rainfed		Rainfed		Rainfed		Rainfed		Rainfed
Cultivation	23.8		23.8		8.4		9.8		12.6		11.2		14.0		-
Seed	9.0		8.8		9.0		6.3		45.6		18.0		20.0		-
Fertilizer	75.5	(37.8)	78.1	(39.0)	64.5	(33.0)	21.6	(10.0)	72.0	(34.9)	94.0	(46.7)	83.3	(41.8)	-
Agro-Chemicals	10.2	(10.0)	10.2	(10.0)	-	-	3.1	(3.0)	9.2	(9.0)	12.3	(12.0)	15.3	(15.0)	-
Harvesting	5.4		6.2		3.3	(3.6)	-	-	-	-	-	-	30.0		-
Other	8.1		8.9		5.8		3.2		20.6		17.5		35.4		-
Interest [3/]		(11.9)		(12.3)		(7.2)		(4.7)		(16.3)		(14.6)		(16.8)	-
Total Cash Inputs	132.0	(106.0)	136.0	(109.0)	91.0	(67.0)	44.0	(37.0)	160.0	(139.0)	153.0	(120.0)	198.0	(173.0)	-
Labor Inputs (man-days/ha)															
Land Preparation	28		28		20		22		24		26		26		-
Planting	24		24		6		5		32		6		38		-
Crop Management	33		35		40		27		55		96		51		-
Harvesting	40		43		44		46		34		67		160		8
Total Labor Inputs	125		130		110		100		145		195		275		8

1/ Economic prices for use in economic analysis, and based on world market prices for rice, barley, soybean, tobacco and fertilizer. Figures in parentheses are financial prices for use in farm budgets. See Annex 10, Table I for individual prices used.

2/ See Table 4 for physical input assumptions.

3/ Interest @ 2.5% /month on production credit for 6 months. Production credit needs calculated as 90% (cash inputs - harvesting costs).

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Crop Production Costs: Future Without Project [1/]

Cash Inputs (Won'000/ha) [2/]	Rice				Barley				Oil Seeds		Vegetables		Red Pepper		Tobacco		Forest
	Rainfed		Irrigated		Rainfed		Irrigated		Rainfed		Rainfed		Rainfed		Rainfed		Rainfed
Cultivation	25.4		25.4		11.3		12.4		9.8		12.6		11.2		14.0		-
Seed	7.7	(9.0)	7.6	(8.9)	9.0		11.0		6.3		45.6		18.0		20.0		-
Fertilizer	46.4	(40.0)	50.1	(43.2)	41.0	(35.5)	40.6	(35.0)	16.5	(14.1)	43.0	(37.0)	61.2	(53.0)	50.3	(43.7)	-
Agro-Chemicals	17.0	(16.6)	15.7	(15.4)	5.1	(5.0)	7.2	(7.0)	3.4	(3.3)	9.8	(9.6)	15.3	(15.0)	18.4	(18.0)	-
Harvesting	10.1	(11.6)	13.6	(15.6)	7.2	(8.0)	7.9	(8.7)	-	-	-	-	-	-	30.0	-	-
Other	11.4		11.6		7.4		7.9		4.0		21.0		19.3		35.3		-
Interest [3/]		(11.0)		(12.9)		(8.8)		(10.0)		(5.5)		(16.2)		(15.5)		(18.0)	-
Total Cash Inputs	118.0	(125.0)	124.0	(133.0)	81.0	(85.0)	87.0	(92.0)	40.0	(43.0)	132.0	(142.0)	125.0	(132.0)	168.0	(179.0)	-
Labor Inputs (man-days/ha)																	
Land Preparation		26		26		14		14		22		24		26		26	-
Planting		24		24		6		6		5		32		6		38	-
Crop Management		35		37		42		42		27		54		96		51	-
Harvesting		35		38		38		38		46		40		67		160	8
Total Labor Inputs		120		125		100		100		100		150		195		275	8

1/ See footnote No. 1, Table 1.

2/ See footnote No. 2, Table 1.

3/ See footnote No. 3, Table 1.

ANNEX 8
Table 2

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Crop Production Costs: Future With Project at Full Development [1]

Cash Inputs (Won'000/ha) [2]	Rice		Barley				Oil Seeds		Vegetables				Red Pepper				Tobacco				Orchard	
	Irrigated		Rainfed		Irrigated		Rainfed		Rainfed		Irrigated		Rainfed		Irrigated		Rainfed		Irrigated		Irrigated	
Cultivation	27.9		18.0		19.0		20.0		20.0		20.0		20.0		20.0		20.0		20.0		14.0	
Seed	7.8	(9.2)	9.0		11.0		6.2		35.9		50.6		18.0		18.0		20.0		20.0		-	
Fertilizer	56.7	(48.6)	42.1	(36.6)	43.3	(37.4)	17.2	(14.9)	31.0	(26.8)	63.9	(54.9)	61.2	(53.0)	65.4	(56.7)	50.3	(43.7)	58.3	(50.9)	86.0	(76.0)
Agro-Chemicals	15.5	(15.2)	10.2	(10.0)	7.2	(7.0)	3.1	(3.0)	8.2	(8.0)	21.5	(21.1)	15.3	(15.0)	18.4	(18.0)	18.4	(18.0)	22.5	(22.0)	240.0	(235.0)
Harvesting	21.9	(25.1)	11.0	(12.1)	11.9	(13.2)	-	-	-	-	-	-	-	-	-	-	30.0		34.0		300.0	
Other	13.2		8.7		8.6		4.5		17.9		29.0		21.5		22.2		35.3		36.2		16.0	
Interest [3]		(14.8)		(10.6)		(10.8)		(6.4)		(14.4)		(23.4)		(17.5)		(18.1)		(18.0)		(20.9)		(65.0)
Total Cash Inputs	143.0	(154.0)	99.0	(105.0)	101.0	(107.0)	51.0	(55.0)	113.0	(123.0)	185.0	(199.0)	136.0	(145.0)	144.0	(153.0)	174.0	(185.0)	191.0	(204.0)	800.0	(850.0)
Labor Inputs (man-days/ha)																						
Land Preparation		23		8		8		10		12		12		14		14		14		14		20
Planting		24		6		6		5		32		32		6		6		38		40		-
Crop Management		35		40		40		27		56		86		100		140		53		61		100
Harvesting		38		36		36		48		45		50		75		80		170		185		240
Total Labor Inputs		120		90		90		90		145		180		195		240		275		300		360

1/ See footnote No. 1, Table 1.

2/ See footnote No. 2, Table 1.

3/ See footnote No. 3, Table 1.

ANNEX 8
Table 3

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Crop Production Costs: Physical Inputs

Inputs/ha		Rice		Barley		Oil Seeds	Vegetables		Orchard	Red Pepper		Tobacco	
		Rainfed	Irrigated	Rainfed	Irrigated	Rainfed	Rainfed	Irrigated	Irrigated	Rainfed	Irrigated	Rainfed	Irrigated
Present:													
Cultivation: - Mechanical 1/	%	-	-	-						-		-	
- Animal 2/	%	100	100	100		100	100			100		100	
Seed: kg		50	49	90		29	-			-			
Fertilizer: kg nutrient - N		117	121	110		26	115			160		90	
- P		72	75	50		30	70			80		110	
- K		61	63	50		27	78			70		100	
Compost: kg		6,000	6,000	6,000		-	2,000			6,000		6,000	
Lime: kg		-	-	-		-	-			200		200	
Threshing: - Mechanical 3/	%	25	25	25		-	-			-		-	
- Manual	%	75	75	75		100	100			100		100	
Future Without Project													
Cultivation: - Mechanical	%	25	25	25	25	-	-			-		-	
- Animal	%	75	75	75	75	100	100			100		100	
Seed: kg		49	46	90	110	29	-			-		-	
Fertilizer: kg nutrient - N		124	136	115	120	35	125			170		95	
- P		77	83	60	60	39	64			90		110	
- K		67	73	55	60	39	70			110		120	
Compost: kg		6,000	6,000	6,000	4,000	900	4,100			6,000		6,000	
Lime: kg		-	-	-	-	-	-			200		200	
Threshing: - Mechanical	%	50	50	50	50	-	-			-		-	
- Manual	%	50	50	50	50	100	100			100		100	
Future With Project													
Cultivation: - Mechanical	%		66	80	90	100	100	100		100	100	100	100
- Animal	%		34	20	10	-	-	-		-	-	-	-
Seed: kg			47	90	110	28	-	-		-	-	-	-
Fertilizer: kg nutrient - N			155	115	125	35	93	178	210	170	190	95	110
- P			103	60	63	38	40	108	100	90	90	110	120
- K			84	55	63	38	50	115	155	110	85	120	150
Compost: kg			4,500	6,000	5,200	-	3,600	3,900	9,000	6,000	6,000	6,000	6,000
Lime: kg			-	200	-	300	-	100	2,000	200	500	200	500
Threshing: - Mechanical	%		70	90	90	-	-	-	-	-	-	-	-
- Manual	%		30	10	10	100	100	100	100	100	100	100	100

1/ Complete mechanical preparation for riceland Won 30,000/ha; other crops Won 20,000/ha.

2/ Hiring cost Won 1,400/animal day.

3/ Mechanical threshing charge by quantity paddy 3%; barley 5%.

ANNEX 8
Table 4

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Crop Budgets 1/

	Rice		Barley		Oil Seeds	Vegetables		Red Pepper		Tobacco		Orchard	Forest
	Rainfed	Irrigated	Rainfed	Irrigated	Rainfed	Rainfed	Irrigated	Rainfed	Irrigated	Rainfed	Irrigated	Irrigated	Rainfed
Present													
Yield (ton/ha)	2.7	3.1	2.0		0.7	15.2		1.3		2.1			2.5
Farm-gate Price (Won'000/ton)	266	266	145		300	50		1,215		630			13
Gross Value of Production (Won'000/ha)	718	825	290		210	760		1,580		1,323			33
Production Costs, Excluding Labor (Won'000/ha)	106	109	67		37	139		120		173			-
Net Value of Production, Excluding Labor (Won'000/ha)	612	716	223		173	621		1,460		1,150			33
Labor Requirements (man-days/ha)	125	130	110		100	145		195		275			8
Future Without Project													
Yield (ton/ha)	2.9	3.9	2.2	2.4	0.9	16.6		1.3		2.1			2.5
Farm-gate Price (Won'000/ton)	266	266	145	145	301	50		1,215		630			13
Gross Value of Production (Won'000/ha)	771	1,037	319	348	271	830		1,580		1,323			33
Production Costs, Excluding Labor (Won'000/ha)	125	133	85	92	43	142		132		179			-
Net Value of Production, Excluding Labor (Won'000/ha)	646	904	234	256	228	688		1,448		1,144			33
Labor Requirements (man-days/ha)	120	125	100	100	100	150		195		275			8
Future With Project													
Yield (ton/ha)		4.5	2.4	2.6	0.9	17.0	23.6	1.3	1.5	2.1	2.5	35.6	
Farm-gate Price (Won'000/ton)		266	145	145	331	52	45	1,215	1,215	630	630	114	
Gross Value of Production (Won'000/ha)		1,197	348	377	298	884	1,062	1,580	1,823	1,323	1,575	4,058	
Production Costs, Excluding Labor (Won'000/ha)		154	105	107	55	123	199	145	153	185	204	850	
Net Value of Production, Excluding Labor (Won'000/ha)		1,043	243	270	243	761	863	1,435	1,670	1,138	1,371	3,208	
Labor Requirements (man-days/ha)		120	90	90	90	145	180	195	240	275	300	360	

1/ Financial costs and prices are used, based on Table 1.

ANNEX 8
Table 5

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Farm Budgets

		0.5 ha Farm			1.5 ha Farm			2.5 ha Farm		
		Present	Future 1/		Present	Future		Present	Future	
			W Project	W Project		W Project	W Project		W Project	W Project
Cropped Area - Rice	(ha)	0.4	0.4	0.4	0.93	0.93	1.24	1.57	1.57	2.08
- Barley	(ha)	0.1	0.1	0.2	0.20	0.35	0.56	0.33	0.58	0.93
- Upland	(ha) 2/	0.1	0.1	0.1	0.57	0.57	0.26	0.93	0.93	0.42
Total	(ha)	0.6	0.6	0.7	1.70	1.85	2.06	2.83	3.08	3.43
Cropping Intensity	(%)	120	120	140	113	123	137	113	123	137
Crop Production - Rice	(kg)	1,140	1,310	1,800	2,650	3,050	5,580	4,480	5,160	9,360
- Barley	(kg)	200	240	520	400	780	1,440	660	1,300	2,390
- Upland	(kg)	1,120	1,220	1,720	2,090	2,240	3,040	3,260	3,490	5,200
Gross Value of Production	(Won'000) 3/	428	483	678	929	1,106	1,918	1,543	1,841	3,191
Production Costs (Excluding Labor)	(Won'000)	64	75	103	137	175	285	227	290	475
Hired Labor	(Won'000) 4/	-	-	-	-	-	26	56	66	192
Taxes	(Won'000) 5/	1	2	13	28	39	88	65	83	164
Farm Income (Before Project Charges)	(Won'000)	363	406	562	764	892	1,519	1,195	1,402	2,360
Water Charges	(Won'000)	4	4	14	8	8	35	13	13	58
Debt Service	(Won'000)	4	4	18	8	8	55 6/	13	13	90 7/
Net Farm Income	(Won'000)	355	398	530	748	876	1,429	1,169	1,346	2,212
Total Labor Requirements	(man-days)	79	77	87	181	190	239	301	315	396
Income from Non-Farming Activities	(Won'000)	65	65	60	50	50	45	35	35	30
Total Income	(Won'000)	420	463	590	798	926	1,474	1,204	1,381	2,242

1/ $\bar{W}$ = Future without project;
W = Future with project.

2/ The upland cropping pattern would vary by farm; however, as calculated for the 1.5 ha farm, an average situation would be:

	$\bar{W}$ Project	W Project	
	Rainfed (ha)	Rainfed (ha)	Irrigated (ha)
Red Pepper	0.02	0.02	0.01
Tobacco	0.02	0.01	-
Oilseed	0.18	0.08	-
Vegetable	0.08	0.06	0.08
Forest	0.27	-	-

3/ Based on Tables 1-3 and 5.

4/ Based on a maximum 45 man-days/month of family labor.

5/ Taxes on riceland - 6% of gross value of production, after deducting 1.4 ton of foodgrain,
on upland - 6% of gross value of production, after deducting Won 85,000/ha.

6/ Repayment on irrigation facilities Won 40,000; on upland reclamation Won 7,000.

7/ Repayment on irrigation facilities Won 65,000; on upland reclamation Won 12,000.

ANNEX 8
Table 6

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Cost and Benefit Recovery

1. The annex examines the implications for public revenues and farmer's incomes of the government's policies towards the recovery of the capital and recurrent costs of the irrigation and upland reclamation components. In determining the extent of cost recovery and the relation of project charges to benefits, two indices have been used, which are defined as follows for the present project:

(a) Cost Recovery Index: the ratio of the present worth of incremental water charges paid by project farmers to present worth of incremental project construction and operation and maintenance costs; and

(b) Rent Recovery Index: the ratio of the present worth of incremental water charges and taxes paid by a typical farm family to the present worth of incremental "project rent" accruing to the family before paying water charges, where "project rent" is defined as net incremental income less the value of family labor, returns to management and incremental investments, and allowances for uncertainty.

The upper limit of the rent recovery index is 100%, but it would normally be less than that because of political difficulties, tax disincentives, and costs of collecting taxes. Rent is a difficult concept to measure in practice, but an attempt is made to determine reasonable quantitative estimates of its various components based on qualitative considerations.

2. All water charges, costs and benefits are measured at present values discounted at 10% annual rate of interest over the 35 year evaluation period, and in terms of 1976 constant prices. Costs and benefits represent financial flows and in determining the cost recovery index, project capital costs are net of taxes. To allow for inflation, in calculating both indices the annual debt service payments are reduced by 7% per year.

3. Korea has a well established system of water charges applying to Government constructed irrigation projects. Beneficiaries must pay full annual O & M costs, plus 30% of actual project construction costs at 3.5% interest over 35 years. The repayment period includes five years grace, then 30 years of repayment.

4. In the cost recovery analysis, US$31.1 million construction costs are charged against the irrigation component. Annual O & M costs are Won 27,650 (US$57)/ha. The present value of construction and O & M costs, discounted at 10%, is US$25.2 million. At full project development, incremental water charges total US$2.0 million per year. Discounted at 10%, their total net present value is US$9.1 million, giving a 36% cost recovery index.

5. For upland reclamation, the official Government policy is to recover 30% of capital cost over eight years at 9% interest including a three year grace period. At a 10% discount rate, the proposed terms imply a cost recovery index of 41%. While the rate of return for upland reclamation is higher than for irrigation (Annex 10), the risk of crop loss is also higher than on irrigated areas (upland areas fully dependent on rainfall). The proposed cost recovery charges, therefore, are satisfactory for this component.

6. In the rent recovery analysis, three farm sizes, 0.5 ha, 1.5 ha and 2.5 ha, are used to represent small, average and large farms. Farm budget data (Annex 8, Tables 5 and 6) are used to derive the net incremental income due to the project for each farm size. Production taxes are 6% of the gross value of grain production in excess of 1.4 ton/farm on riceland; and 6% of the gross value of production after a deduction of Won 85,000/ha on upland. Due to insufficient data, other taxes, such as import duties and sales tax, have not been considered.

7. In deciding project rent, farm depreciation was calculated at 5% of the incremental capital cost for equipment; 3% for buildings; and 2% for land development works. Incremental family labor was valued at Won 1,450 per man-day, while the value of the farmers' management was valued at 10% of gross incremental income. The return on the farmers' own investment was calculated at 10% of its market value, while an uncertainty allowance of 20% of gross incremental was assumed for the three farms. Under these assumptions, and discounting incremental project rent and project charges at 10% over the 35-year evaluation period, rent recovery varied from 27% for the 0.5 ha farm to 18% for the two larger farms. If the interest rate is lifted from 3.5% to 9.0% per year on the capital repayments for irrigation works, the rent recovery increases to about 36% for the 0.5 ha farm and 24% for the other two farms (Table 1).

8. Rent recovery is higher for the 0.5 ha farm compared to the larger farms since although the unit development cost is approximately the same for all farms, and correspondingly so is the amount of capital repayment per developed ha, the percentage income increase is much greater on the 1.5 ha and 2.5 ha farms compared to the 0.5 ha farm.

9. The rent recovery calculations are imprecise for the following reasons:

(a) information is meager on land use by farm size in the project area, particularly regarding the two larger model farm;

(b) agriculture in the project area is already quite intensive, and the increment of labor due to the project is difficult to determine accurately without additional survey data;

(c) management skills cannot be easily quantified in monetary terms; and

(d) the farmers' investment in equipment and farm improvements can only be estimated approximately without detailed socio-economic surveys.

10. Assuming that all project rent is spent for consumption and not saved, the optimum water charges would be zero for those households with incomes below the critical consumption level (CCL) and 100% of the project rent for those with incomes above that level. The estimated Korean's CCL is US$165/capita (1976 prices). At present, an estimated 33% of the farmers (0.6 ha farm or less) are below the CCL. At full project development, an estimated 15% of the farmers (0.4 ha farm or less) would be below.

11. A forthcoming Bank economic mission will review price policies in the agriculture sector and urban/rural income distribution which have a bearing on appropriate levels of cost recovery. At present, the Government's repayment policy is uniform throughout the country, and laid down by law. Any change to this law should await discussion of the mission findings with the Government.

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MIHO WATERSHED AREA DEVELOPMENT PROJECT

Rent Recovery 1/

		Farm		
		0.5 ha	1.5 ha	2.5 ha
		(Won'000)		
1.	Incremental - Gross Value of Farm Production	195	812	1,350
2.	- Less Production Cash Costs	28	136	311
3.	Sub-total	167	676	1,039
4.	- Less Depreciation 2/	8	24	41
5.	- Less Imputed Family Labor Value 3/	14	47	3
6.	- Less Imputed Farmer's Management 4/	20	81	135
7.	- Less Imputed Return on own Capital 5/	8	20	32
8.	- Less Allowance for Risk/Uncertainity 6/	39	163	270
9.	- Less Additional Taxes	11	49	81
10.	Equals Rent/Surplus	67	292	477
11.	Incremental - Water Charges	10	27	45
12.	- Capital Repayments	14	47	77
13.	- Total Direct Charges [(11) + (12)]	25	74	122
14.	Rent Recovery (%) 7/	27	18	19
15.	Incremental - Water Charges	10	27	45
16.	- Capital Repayments	26	77	129
17.	- Total Direct Charges [(15) + (16)]	36	104	174
18.	Rent Recovery (%) 8/	36	23	24

1/ Figures from Annex 8, Table 6.

2/ Equipment @ 5% of cost; buildings @ 3%; land development works @ 2%.

3/ At Won 1,450 per man-day.

4/ At 10% of gross incremental farm income.

5/ At 10% of farmers' own incremental investment funds.

6/ At 20% of gross incremental farm income.

7/ In net present values, time streams discounted at 10% over 35 years; irrigation capital repayments at 3.5% interest with five years grace, then 30 years of repayments; upland capital repayments over eight years at 9% interest. Capital repayments were discounted at 7% annual interest for expected general inflation.

8/ Similar to No. 7, except irrigation capital repayment at 9.0% interest.

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Economic Analysis

Prices

1. All prices have been adjusted to January, 1976 levels. All farm-inputs and output were evaluated at projected 1985 farm-gate prices expressed in January, 1976 constant prices.

2. The farm-gate rice price is calculated as follows:

	US$/ton (milled basis)
Forecast 1985 world market price (in January, 1976 constant dollars) /1	350
Ocean freight and insurance	35
Import price cif Incheon/Busan	385
Rice Price, project area /2	385
Value of by-product (straw)	30
Farm-gate rice price	415 (Won 232,000) /3

/1 The commodity price forecast for Thai 5% broken fob Bangkok in 1985 (in terms of mid-1976 constant dollars) is US$359/ton. This price was adjusted to a January, 1976 unit value by using a conversion factor equal to 96.8 (mid-1976 = 100). Most of Korea's rice imports are of U.S. origin and are equivalent to or better than Thai 5% broken in quality.

/2 The value of port handling charges is taken as equal to the value of inland transport costs. The cost of milling has been assumed offset by the value of bran produced.

/3 Using shadow foreign exchange Won 560 = US$1.

3. Since no world market price projection is available for barley intended for human consumption, polished barley was assumed to be worth 85% of the value of wheat flour, based on observed trends. This ratio reflects the

taste preference of Korean consumers for wheat flour. Prices of soybean, tobacco and fertilizer are based on the Bank's projection of 1985 world market prices. For the remaining crops, which are not traded internationally, prices used were actual farm-gate prices averaged over five years (1971-75) and adjusted for inflation. All commodity prices were converted from an fob to a farmgate basis by adding US$35 per ton, to represent the average value of insurance, shipping and inland transport to the major market centers minus the cost of transporting the farm produce to the market centers. Table I shows all present and future prices used in the economic analysis and farm budget analysis.

Foreign Exchange

4. Due to the existence of import taxes, quantitative restrictions and export subsidies, the official exchange rate of Won 485 = US$1 understates the cost to the economy of foreign exchange used in carrying out the project and savings through increased foodgrain production. According to the results of studies conducted by the Korean Development Institute, the effective rate of foreign exchange is about 15% higher than the nominal rate. Therefore, a shadow foreign-exchange rate of Won 560 = US$1 has been used to value the internationally traded commodities and foreign-exchange component of inputs and construction costs.

Labor Analysis

5. The demand for labor in the rural areas of Korea is highly seasonal in character. During the cropping season (April to October) there is little unemployment and in peak months (June and October) labor shortages may even develop. As the rural labor force is relatively mobile, the labor market works fairly efficiently and therefore the observed market wage rate for the hired labor provides a good estimate of the opportunity cost of farm labor during the cropping season. Thus the labor has been valued at Won 1,600/man-day for the cropping season. During the winter season, there is little wage farm employment. There is, however, some self-employment, notably the weaving of bags from rice straw. The net income from this activity is about Won 500/man-day and the value has been used as the opportunity cost of unskilled labor in the winter months, November to March. For the purposes of this analysis, it was assumed that, on the average, 85% of farm labor requirement occurs during the main season and 15% during the off-season. The resulting weighted average labor cost is Won 1,450/day.

Benefits

6. Benefits are estimated from the increased crop production resulting from the irrigation and land development; and time savings and a reduction in transport costs arising from the village access road development. Benefits have not been individually quantified for the stream channel improvement component as this is regarded as a complementary investment to the other project works. The expected crop yields, prices, gross returns, production costs, net returns (without accounting for labor costs), and labor requirements per

ha are shown in Annex 8. Chart 15823 shows the proposed cropping calendar. Transportation cost savings result from the time savings of using trucks rather than man-carried A-frames (chigae) to transport agricultural inputs and outputs. The basis for the savings are the same as those explained in Annex 20 of the Appraisal of the Rural Infrastructure Project (Report No. 958a-KO, February 15, 1976). They are estimated at US$1.3 million per year. Table 2 shows the expected project benefits at full agricultural development of the project.

Investment Costs

7. As calculated for the economic analysis and expressed in January, 1976 prices, the total investment cost is US$38.9 million. This consists of dams and canals (US$23.6 million); land development (US$14.0 million); surveys, mapping, vehicles and technical assistance (US$1.0 million) and farmers' development cost for initial orchard establishment (US$0.3 million). In determining the US$ value of investment costs, local costs were converted at the shadow exchange rate of US$1 = Won 560 (para 4). Investment costs have been adjusted to exclude taxes and transfer payments (construction costs reduced 10%), and reflect the use of unskilled labor in off-season periods (construction costs reduced 5%). Costs include physical contingencies, but exclude price contingencies. Estimated annual O & M costs are US$57/ha for the irrigated area. As the evaluation is only over 35 years, the project facilities are assumed to have a salvage value of 25% of their original cost at the end of the evaluation period. The investment costs do not include any allowance for the farmer's own investment in on-farm development in areas to be irrigated, as this is a small proportion of total costs, highly variable between different areas and thus difficult to quantify. As the work would be spread over several months and would be done at times when the farmer would otherwise be unemployed, the opportunity cost of this labor would be small and hence has been neglected.

Development Period

8. According to the project implementation schedule, the Kumwang dam (1,500 ha), Maengdong dam (2,360 ha), and the Baekgok dam (1,685) areas would be completed in early 1980, and the 1980 rice crop would be first grown under improved conditions (total areas, 5,545 ha); the Weonnam dam (1,570 ha), small dams (1,200 ha) and all land development (4,350 ha) areas would be completed from early to mid-1981, and the 1981 crops would be the first under improved conditions (total area, 7,120 ha). Commencing with the first crop grown under upgraded conditions, farmers would achieve the projected yield levels over five years in equal instalments. The orchards would reach maximum production in 12 years. The project would reach full development in 1986; except for orchards which would reach full production five years later in 1991.

9. Using the foregoing assumptions and discounting the project's benefits and costs over 35 years, the economic rate of return is 15% (Table 6).

Sensitivity Analysis

10. Sensitivity of the rate of return was tested to cost overruns; reductions and delays in benefits; and a 25% increase in project benefits. The effects of these changes in assumptions were as follows:

	Alternative	Rate of Return (%)
(a)	A 20% increase in construction costs	14
(b)	A two-year delay in reach full project benefits	13
(c)	A combination of a 20% increase in construction costs and a two-year delay in reaching full project benefits	12
(d)	A 25% decrease in project benefits because farmers failed to attain projected yields and/or cropping intensity	12
(e)	A 25% increase in project benefits due to higher commodity prices	18

Project Components

11. Using the general assumptions already described, the following project components were evaluated individually: each of the four dams' systems and service areas; the small dams and their service areas; upland reclamation of 1,200 ha; and land consolidation of the 3,150 ha already irrigated. Costs of other project works, (conversion of uplands to paddy, irrigated upland development, orchard development, remaining 1,450 ha land consolidation, village access roads, and channel improvements), which are regarded as complementary investments to other project works, were included under the appropriate foregoing component. Investment costs for each component are:

Kumwang dam US$7.1 million, consisting of dams and canals (US$5.6 million), land development, village access roads and channel improvement (US$1.5 million);

Maengdong dam US$8.1 million, consisting of dams and canals (US$6.2 million), land development, village access roads and channel improvement (US$1.9 million);

Baekgok dam US$5.5 million, consisting of dams and canals (US$4.3 million), land development, village access roads, and channel improvement (US$1.2 million);

Weonnam dam US$6.4 million, consisting of dams and canals (US$4.9 million), land development, village access roads, and channel improvement (US$1.5 million);

Small dams US$5.2 million, consisting of dams and canals (US$4.4 million), land development, village access roads and channel improvements (US$0.8 million);

Upland Reclamation (1,200 ha) US$1.8 million consisting of reclamation works (US$1.7 million), village access roads (US$0.1 million); and

Land Consolidation (3,150 ha) US$4.8 million, consisting of consolidation works (US$3.4 million), villages access roads and channel improvements (US$1.4 million).

Table 2 shows the expected sub-project's benefits at full agricultural development; Tables 3 to 5 show the derivation of agricultural benefits; and Tables 7 and 8 show the expected time flows of sub-project costs and benefits. The rates of return are as follows:

Component	Rate of Return %
Kumwang Dam	13
Maengdong Dam	17
Baekgok Dam	15
Weonnam Dam	12
Small Dams	12
Upland Reclamation (1,200 ha)	35
Land Consolidation (3,150 ha)	14

12. Sensitivity of these rates of return was tested to cost overruns and to reductions and delays in the benefits. The results (Table 9) show less sensitivity to cost overruns and delays in reaching full project benefits than to level of benefits. Except for a 25% decrease in projected benefits from the Weonnam dam and the Small dams, however, in none of cases tested would the rate of return fall below 10%. On the other hand, if the level of benefits are 25% higher than forecasted, the rates of return would be 2 to 3% higher than the base estimates.

ANNEX 10
Table 1

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Input and Output Prices
(Won'000/ton)

	Present		Future	
	Financial	Economic	Financial	Economic
Crops				
HYV Rice	266	266	266	232
Local Variety Rice	266	266	266	232
Common Barley	145	131	145	131
White Potato	66	66	66	66
Soybean	182	153	182	185
Tobacco	630	784	630	784
Red Pepper	1,215	1,215	1,215	1,215
Sesame	720	720	720	720
Chinese Cabbage	38	38	38	38
Sweet Potato	53	53	53	53
Apples	120	120	120	120
Pears	93	93	93	93
Fertilizers (per nutrient ton)				
Nitrogen	168	350	168	198
Phosphate	140	355	140	173
Potash	54	68	54	55
Pesticides				
Pesticides	1,425	1,455	1,425	1,455
Seeds				
HYV Rice	180	180	232	194
Local Variety Rice	180	180	180	155
Common Barley	100	100	100	100
White Potato	100	100	100	100
Soybean	200	200	200	200
Tobacco (Won/ha)	20,000	20,000	20,000	20,000
Red Pepper (Won/ha)	18,000	18,000	18,000	18,000
Sesame	720	720	720	720
Chinese Cabbage (Won/ha)	23,500	23,500	23,500	23,500
Sweet Potato	55	55	55	55

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Economic Analysis: Net Value of Agricultural Production at Full Project Development

	Net Return to Project Area Without Costing Farm Labor 2/ (Won million)		Incremental Net Return (Won million)	Less Incremental Farm Labor Cost 1/ (Won million)	Incremental Net Value of Production	
	Without Project	With Project			(Won million)	(US$'000)
Complete Project	7,440	13,720	6,280	720	5,560	9,928
Kumwang Dam	778	1,921	1,143	90	1,053	1,880
Maengdong Dam	1,341	2,962	1,621	126	1,495	2,669
Baegkok Dam	967	1,797	830	63	767	1,370
Weonnam Dam	964	1,613	649	51	598	1,068
Small Dams	674	1,364	690	63	627	1,120
Land Consolidation (3,150 ha)	2,676	3,216	540	45	495	884
Upland Reclamation (1,200 ha)	40	847	807	282	525	937

1/ The difference in total farm labor requirement between "with" and "without" project conditions costed at Won 1,450/manday.

2/ From Tables 3, 4 and 5; and from Annex 7, Tables 2 and 3.

ANNEX 10
Table 2

ANNEX 10
Table 3

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Economic Analysis - Net Value of Production

		Area (ha)	Yield (ton/ha)	Farm Gate Price (Won '000/ton)	Gross Value of Production	Production Cost 1/ (Won '000/ha)	Net Value of Production	Net Returns from Project Area (Won million)
				Kumwang Dam				
Irrigated								
Rice	$\bar{W}$ 2/	-	-	-	-	-	-	-
	W	1,300	4.5	232	1,044	143	901	1,171
Barley	$\bar{W}$	-	-	-	-	-	-	-
	W	410	2.6	131	341	101	240	98
Orchard	$\bar{W}$	-	-	-	-	-	-	-
	W	200	35.6	114	4,058	800	3,258	652
Rainfed								
Rice	$\bar{W}$	995	2.9	232	673	118	555	552
	W	-	-	-	-	-	-	-
Barley	$\bar{W}$	290	2.2	131	288	81	207	60
	W	-	-	-	-	-	-	-
Upland	$\bar{W}$	285	-	-	-	-	-	159
	W	-	-	-	-	-	-	-
Uncultivated Forest	$\bar{W}$	200	2.5	13	33	-	33	7
	W	-	-	-	-	-	-	-
Total	$\bar{W}$							778
	W							1,921
Increment								1,143
				Maengdong Dam				
Irrigated								
Rice	$\bar{W}$	-	-	-	-	-	-	-
	W	1,840	4.5	232	1,044	143	901	1,658
Barley	$\bar{W}$	-	-	-	-	-	-	-
	W	730	2.6	131	341	101	240	175
Upland	$\bar{W}$	-	-	-	-	-	-	-
	W	345	-	-	-	-	-	412
Orchard	$\bar{W}$	-	-	-	-	-	-	-
	W	220	35.6	114	4,058	800	3,258	717
Rainfed								
Rice	$\bar{W}$	1,205	2.9	232	673	118	555	669
	W	-	-	-	-	-	-	-
Barley	$\bar{W}$	600	2.2	131	288	81	207	124
	W	-	-	-	-	-	-	-
Upland	$\bar{W}$	940	-	-	-	-	-	541
	W	-	-	-	-	-	-	-
Uncultivated Forest	$\bar{W}$	220	2.5	13	33	-	33	7
	W	-	-	-	-	-	-	-
Total	$\bar{W}$							1,341
	W							2,962
Increment								1,621

1/ From Annex 8; economic cost excluding labor.

2/ $\bar{W}$ = Future without the project;
W = Future with project.

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Economic Analysis - Net Value of Production

		Area (ha)	Yield (ton/ha)	Farm Gate Price (Won '000/ton)	Gross Value of Production	Production Cost 1/ (Won '000/ha)	Net Value of Production	Net Returns from Project Area (Won million)
Baekgok Dam								
Irrigated								
Rice	$\bar{W}$ 2/	-	-	-	-	-	-	-
	W	1,550	4.5	232	1,044	143	901	1,397
Barley	$\bar{W}$	-	-	-	-	-	-	-
	W	535	2.6	131	341	101	240	128
Upland	$\bar{W}$	-	-	-	-	-	-	-
	W	95	-	-	-	-	-	109
Orchard	$\bar{W}$	-	-	-	-	-	-	-
	W	50	35.6	114	4,058	800	3,258	163
Rainfed								
Rice	$\bar{W}$	935	2.9	232	623	118	555	519
	W	-	-	-	-	-	-	-
Barley	$\bar{W}$	415	2.2	131	288	81	207	86
	W	-	-	-	-	-	-	-
Upland	$\bar{W}$	620	-	-	-	-	-	357
	W	-	-	-	-	-	-	-
Uncultivated Forest	$\bar{W}$	135	2.5	13	33	-	33	5
	W	-	-	-	-	-	-	-
Total	$\bar{W}$							967
	W							1,797
Increment								830
Small Dams								
Irrigated								
Rice	$\bar{W}$	-	-	-	-	-	-	-
	W	1,120	4.5	232	1,044	143	901	1,009
Barley	$\bar{W}$	-	-	-	-	-	-	-
	W	390	2.6	131	341	101	240	94
Orchard	$\bar{W}$	-	-	-	-	-	-	-
	W	80	35.6	114	4,058	800	3,258	261
Rainfed								
Rice	$\bar{W}$	990	2.9	232	673	118	555	550
	W	-	-	-	-	-	-	-
Barley	$\bar{W}$	210	2.2	131	288	81	207	43
	W	-	-	-	-	-	-	-
Upland	$\bar{W}$	135	-	-	-	-	-	78
	W	-	-	-	-	-	-	-
Uncultivated Forest	$\bar{W}$	80	2.5	13	33	-	33	3
	W	-	-	-	-	-	-	-
Total	$\bar{W}$							674
	W							1,364
Increment								690

1/ From Annex 8; economic cost excluding labor.

2/ $\bar{W}$ = Future without the project;
W = Future with the project.

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Economic Analysis - Net Value of Production

		Area (ha)	Yield (ton/ha)	Farm Gate Price (Won '000/ton)	Gross Value of Production	Production Cost 1/ (Won '000/ha)	Net Value of Production	Net Return from Project Area (Won million)
Weonnam Dam								
Irrigated								
Rice	$\bar{W}$ 2/	-	-	-	-	-	-	-
	W	1,460	4.5	232	1,044	143	901	1,315
Barley	$\bar{W}$	-	-	-	-	-	-	-
	W	605	2.6	131	341	101	240	145
Upland	$\bar{W}$	-	-	-	-	-	-	-
	W	135	-	-	-	-	-	153
Rainfed								
Rice	$\bar{W}$	1,100	2.9	232	673	118	555	611
	W	-	-	-	-	-	-	-
Barley	$\bar{W}$	375	2.2	131	288	81	207	78
	W	-	-	-	-	-	-	-
Upland	$\bar{W}$	480	-	-	-	-	-	275
	W	-	-	-	-	-	-	-
Total	$\bar{W}$							964
	W							1,613
Increment								649
Upland Reclamation (1,200 ha)								
Rainfed								
Barley	$\bar{W}$	-	-	-	-	-	-	-
	W	600	2.4	131	314	99	215	129
Red Pepper	$\bar{W}$	-	-	-	-	-	-	-
	W	145	1.3	1,215	1,580	136	1,444	209
Tobacco	$\bar{W}$	-	-	-	-	-	-	-
	W	50	2.1	784	1,646	174	1,472	74
Oil Seeds	$\bar{W}$	-	-	-	-	-	-	-
	W	540	0.9	302	272	51	221	119
Vegetables	$\bar{W}$	-	-	-	-	-	-	-
	W	410	17.0	52	884	113	771	316
Uncultivated Forest	$\bar{W}$	1,200	2.5	13	33	-	33	40
	W	-	-	-	-	-	-	-
Total	$\bar{W}$							40
	W							847
Increment								807
Land Consolidation (3,150 ha)								
Irrigated								
Rice	$\bar{W}$	3,150	3.9	232	905	124	781	2,460
	W	3,150	4.5	232	1,044	143	901	2,838
Barley	$\bar{W}$	950	2.4	131	314	87	227	216
	W	1,575	2.6	131	341	101	240	378
Total	$\bar{W}$							2,676
	W							3,216
Increment								540

1/ From Annex 8; economic cost excluding labor.

2/ $\bar{W}$ = Future without the project;
W = Future with project.

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Economic Costs and Benefits: All Components
(US$ million)

Year		Project Costs			Incremental Project Benefits
		Capital	O & M	Total	
1	(1976)	0.3	0	0.3	0
2	(1977)	5.4	0	5.4	0
3	(1978)	9.0	0	9.0	0
4	(1979)	11.3	0	11.3	0
5	(1980)	7.8	0.3	8.1	0.7
6	(1981)	5.1	0.5	5.6	2.3
7	(1982)	0	0.5	0.5	3.9
8	(1983)	0	0.5	0.5	5.5
9	(1984)	0	0.5	0.5	7.1
10	(1985)	0	0.5	0.5	8.5
11	(1986)	0	0.5	0.5	8.9
12	(1987)	0	0.5	0.5	9.4
13	(1988)	0	0.5	0.5	9.8
14	(1989)	0	0.5	0.5	10.3
15	(1990)	0	0.5	0.5	10.8
16	(1991)	0	0.5	0.5	11.2
17-34	(1992-2009)	0	0.5	0.5	11.2
35	(2010)	0	0.5	0.5	20.3
Economic Rate of Return					15%

ANNEX 10
Table 7

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Economic Cost and Returns
(US$ million)

Year	Project Costs Capital	O & M	Total	Incremental Project Benefits
		Kumwang Dam		
1	0.2	0	0.2	0
2	1.4	0	1.4	0
3	2.2	0	2.2	0
4	2.6	0	2.6	0
5	0.7	0	0.7	0.2
6	0	0.1	0.1	0.4
7	0	0.1	0.1	0.5
8	0	0.1	0.1	0.7
9	0	0.1	0.1	1.0
10	0	0.1	0.1	1.2
11	0	0.1	0.1	1.3
12	0	0.1	0.1	1.5
13	0	0.1	0.1	1.6
14	0	0.1	0.1	1.7
15	0	0.1	0.1	1.9
16	0	0.1	0.1	2.0
17-34	0	0.1	0.1	2.0
35	0	0.1	0.1	3.7
Economic Rate of Return				13%
		Baegkok Dam		
1	0	0	0	0
2	0.2	0	0.2	0
3	2.4	0	2.4	0
4	2.4	0	2.4	0
5	0.5	0.1	0.6	0.2
6	0	0.1	0.1	0.5
7	0	0.1	0.1	0.7
8	0	0.1	0.1	1.0
9	0	0.1	0.1	1.2
10	0	0.1	0.1	1.3
11	0	0.1	0.1	1.3
12	0	0.1	0.1	1.3
13	0	0.1	0.1	1.4
14	0	0.1	0.1	1.4
15	0	0.1	0.1	1.4
16	0	0.1	0.1	1.5
17-34	0	0.1	0.1	1.5
35	0	0.1	0.1	2.9
Economic Rate of Return				15%

Year	Project Costs Capital	O & M	Total	Incremental Project Benefits
		Maengdong Dam		
1	0.2	0	0.2	0
2	1.6	0	1.6	0
3	2.5	0	2.5	0
4	3.0	0	3.0	0
5	0.8	0.1	0.9	0.3
6	0	0.1	0.1	0.6
7	0	0.1	0.1	1.0
8	0	0.1	0.1	1.3
9	0	0.1	0.1	1.8
10	0	0.1	0.1	1.9
11	0	0.1	0.1	2.1
12	0	0.1	0.1	2.3
13	0	0.1	0.1	2.4
14	0	0.1	0.1	2.6
15	0	0.1	0.1	2.7
16	0	0.1	0.1	2.9
17-34	0	0.1	0.1	2.9
35	0	0.1	0.1	4.8
Economic Rate of Return				17%
		Small Dams		
1	0.2	0	0.2	0
2	0.9	0	0.9	0
3	1.0	0	1.0	0
4	1.2	0	1.2	0
5	1.1	0	1.1	0.1
6	0.8	0	0.8	0.2
7	0	0.1	0.1	0.3
8	0	0.1	0.1	0.5
9	0	0.1	0.1	0.6
10	0	0.1	0.1	0.8
11	0	0.1	0.1	0.9
12	0	0.1	0.1	0.9
13	0	0.1	0.1	1.0
14	0	0.1	0.1	1.1
15	0	0.1	0.1	1.1
16	0	0.1	0.1	1.2
17-34	0	0.1	0.1	1.2
35	0	0.1	0.1	2.3
Economic Rate of Return				12%

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Economic Costs and Returns
(US$ million)

Year	Project Costs			Incremental Project Benefits
	Capital	O & M	Total	
	Weonnam Dam			
1	0	0	0	0
2	0.2	0	0.2	0
3	1.3	0	1.3	0
4	2.0	0	2.0	0
5	2.3	0	2.3	0
6	0.6	0	0.6	0.2
7	0	0.1	0.1	0.5
8	0	0.1	0.1	0.7
9	0	0.1	0.1	0.9
10-34	0	0.1	0.1	1.2
35	0	0.1	0.1	2.8
Economic Rate of Return				12%
	Land Consolidation (3,150 ha)			
1	0	0	0	0
2	1.0	0	1.0	0
3	1.0	0	1.0	0
4	1.2	0	1.2	0
5	1.2	0	1.2	0
6	0.4	0	0.4	0.2
7	0	0	0	0.4
8	0	0	0	0.6
9	0	0	0	0.8
10-34	0	0	0	1.0
35	0	0	0	2.2
Economic Rate of Return				16%

Year	Project Costs			Incremental Project Benefits
	Capital	O & M	Total	
	Upland Reclamation			
1	0	0	0	0
2	0.1	0	0.1	0
3	0.4	0	0.4	0
4	0.6	0	0.6	0
5	0.6	0	0.6	0
6	0.1	0	0.1	0.3
7	0	0	0	0.6
8	0	0	0	0.9
9	0	0	0	1.2
10-34	0	0	0	1.4
35	0	0	0	1.9
Economic Rate of Return				35%

ANNEX 10
Table 8

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

Sensitivity Analysis: Project Components

	Kumwang Dam	Maengdong Dam	Baegkok Dam	Weonnam Dam	Small Dams	Upland Reclamation	Land Consolidation
	(%)						
Best Estimate	13	17	15	12	12	35	14
Construction Costs increased 20%	12	15	13	10	11	31	12
Benefits delayed by 2 years	12	14	12	10	10	26	11
Benefits decreased by 25%	11	14	11	9	9	30	11
Benefits increased by 25%	16	20	18	15	15	40	16

ANNEX 10
Table 9

ANNEX 11
Table 1

KOREA

MIHO WATERSHED AREA DEVELOPMENT PROJECT

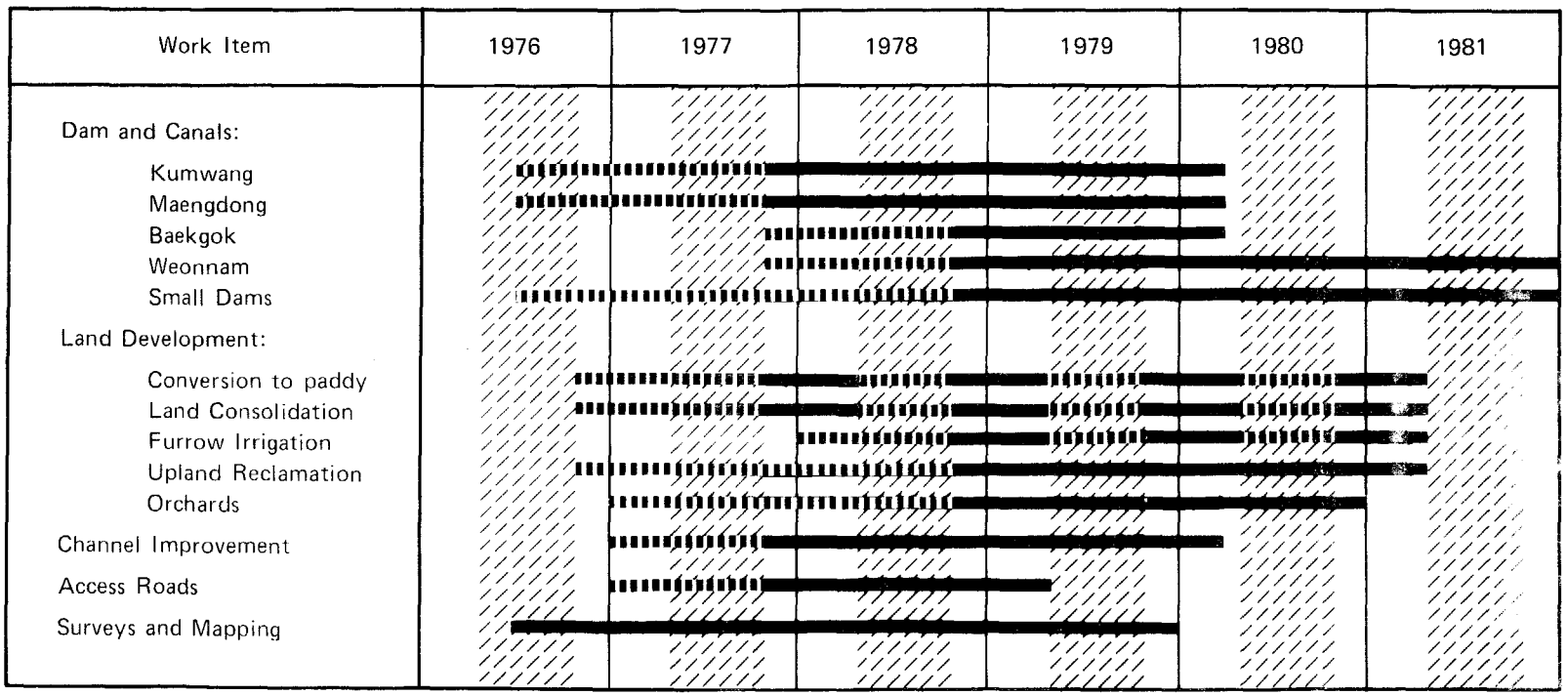
SCHEDULE OF CRITICAL EVENTS

	Activity	Responsible Agency	Target Date
A.	Irrigation Development (Dams and Canals)	OWD/ADC	
	1. Civil works contracts (ICB)		
	(a) Complete detailed engineering design, tender documents, prequalification and advertise		
	i. Kumwang, Maengdong dams and small dams		Feb., 1977
	ii. Baekgok and Weonnam dams		Feb., 1978
	(b) Evaluate bids and award contracts		
	i. Kumwang, Maengdong dams		July, 1977
	ii. Baekgok and Weonnam dams, and small dams		July, 1978
	(c) Start construction		
	i. Kumwang, Maengdong dams and small dams		Oct., 1977
	ii. Baekgok and Weonnam dams, and small dams		Oct., 1978
B.	Land Development	OWD/ADC	
	1. Civil works contracts (ICB)		
	(a) Complete detailed design, tender documents, prequalification, and advertise (ICB)		
	i. Land consolidation		Feb., 1977
	ii. Furrow irrigation		Feb., 1978
	iii. Orchards		Mar., 1978
	iv. Conversion to paddy		Feb., 1977
	v. Upland reclamation		Feb., 1978
	(b) Evaluate bids and award contracts		
	i. Land consolidation		July, 1977
	ii. Furrow irrigation		July, 1978
	iii. Orchards		July, 1978
	iv. Conversion to Paddy		July, 1977
	v. Upland Reclamation		July, 1978
	(c) Start construction		
	i. Land consolidation		Oct., 1977
	ii. Furrow irrigation		Oct., 1978
	iii. Orchards		Oct., 1978
	iv. Conversion to Paddy		Oct., 1977
	v. Upland reclamation		Oct., 1978

ANNEX 11
Table 1

	Activity	Responsible Agency	Target Date
C.	Channel Improvement	OWD	
	1. Civil works contracts (ICB)		
	(a) Complete detailed design, tender documents, prequalifications and advertise (ICB).		Mar., 1977
	(b) Evaluate bids and award contracts		Aug., 1977
	(c) Start construction		Oct., 1977
D.	Access Roads	OWD	
	2. Period of construction		Oct., 1977 -June 1979

KOREA
MIHO WATERSHED AREA DEVELOPMENT PROJECT
Implementation Schedule



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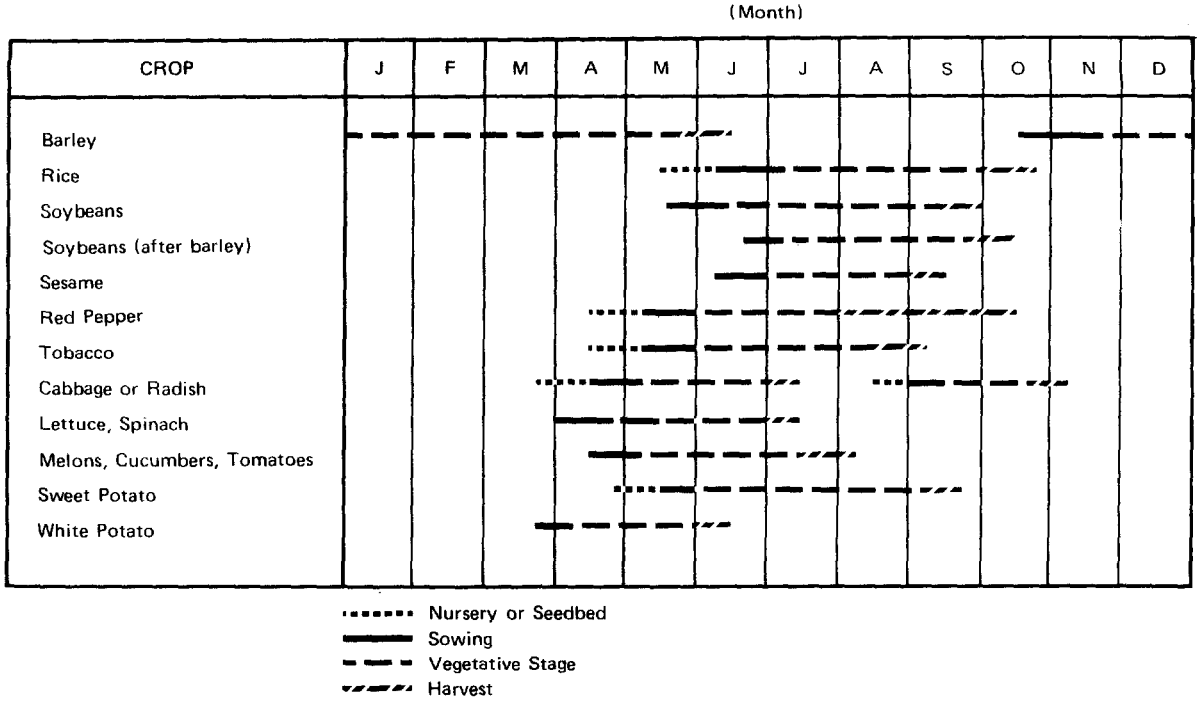
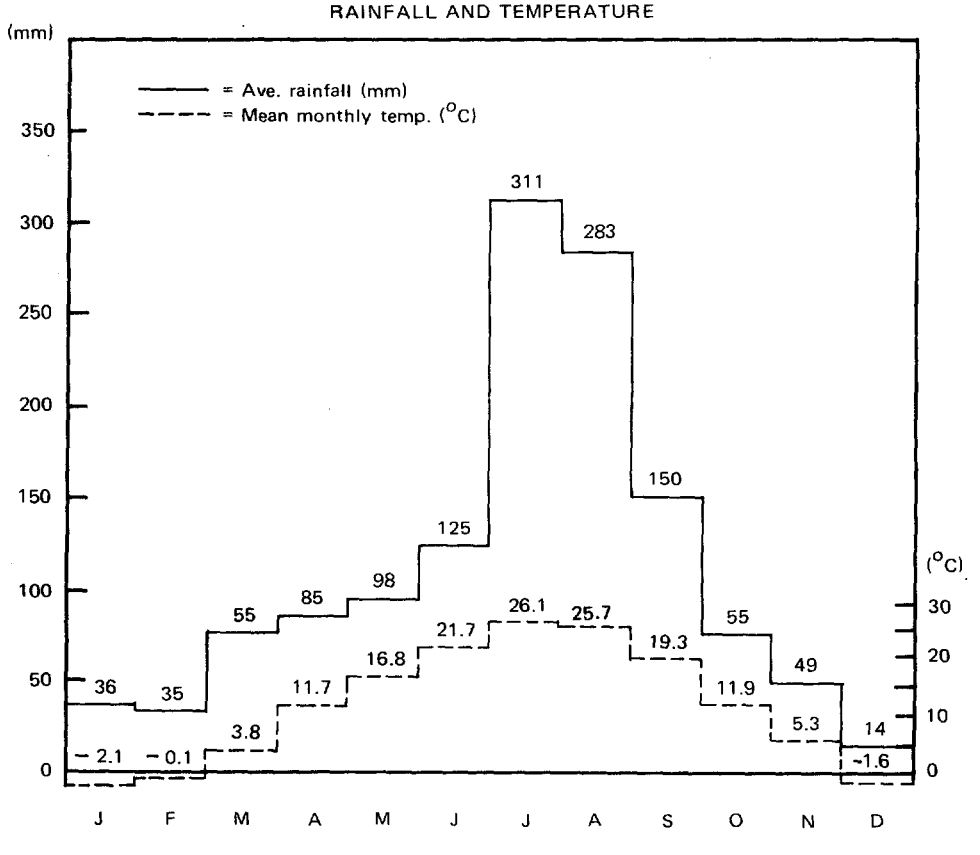
MIHO WATERSHED AREA DEVELOPMENT PROJECT
Proposed Cropping Calendar





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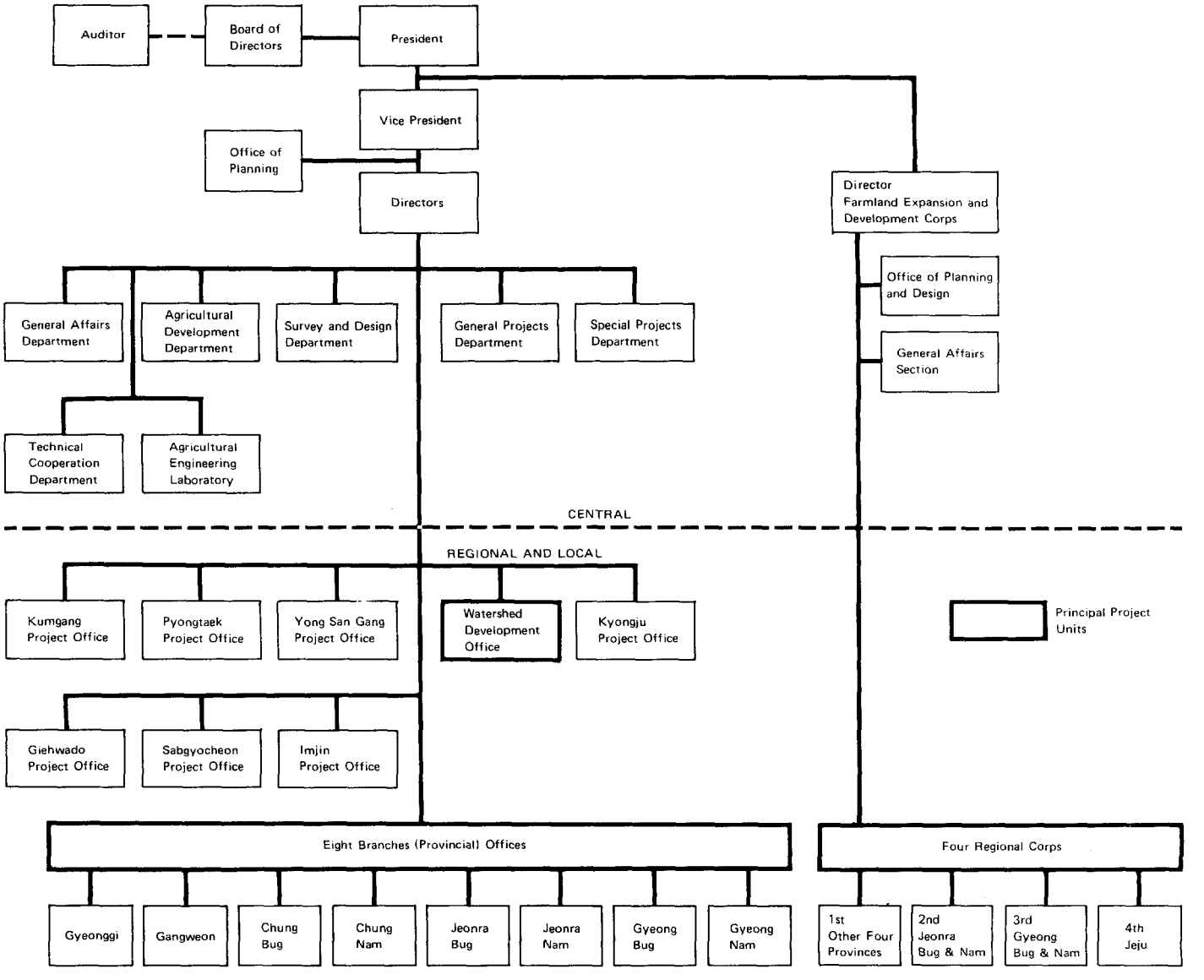
KOREA
MIHO WATERSHED AREA DEVELOPMENT PROJECT
Organization Chart of the Agricultural Development Corporation (Simplified)



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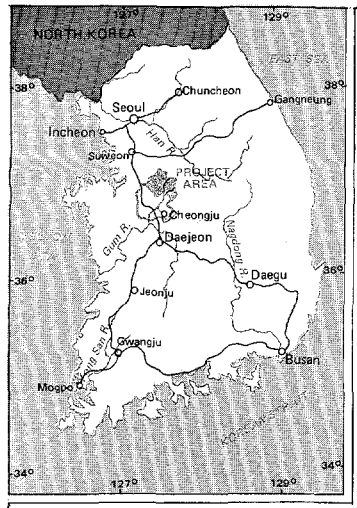

The boundaries shown on this map do not imply endorsement or acceptance by the World Bank and its affiliates.

IRRIGATED AREA(EXISTING)
PROPOSED IRRIGATION AREA
UPLAND RECLAMATIONS
EXISTING DAM
NEW DAMS
PROPOSED IRRIGATION CANALS
TOWNS
ROADS
RAILWAYS
RIVERS AND RESERVOIRS
SUB WATERSHED BOUNDARIES
WATERSHED BOUNDARY
COUNTY(GUN) BOUNDARIES

TO CHANGHOWEON
TO ANSEONG
ANSEONG GUN
KUMWANG
DAM I
KUMWANG
DAM II
TO CHUNGJU
EUMSEONG GUN
JINCHEON GUN
TO BOEANGCHEON
MAENGDONG
DAM I
DAM II
TO CHUNGJU
BAEGKOK
JINCHEON
WEONNAM
JOPYEONG RESERVOIR
GAESAN GUN
TO GAESAN
JEUNGPYEONG
CHEONGAN
TO CHEONGJU
TO CHEONGJU
TO BOEBJUSA

0 2 4 6 8 10
KILOMETERS

0 2 4 6 8
MILES